POWER and THE ENGINEER
EVERYTHING ABOUT THE GENERATION AND TRANSMISSION OF POWER

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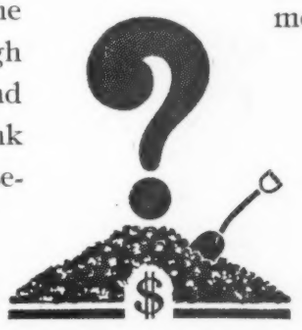
SOME steam plants are not run to make money—but they are charity plants. The ordinary plant is run to make dollars for the man who owns it.

But the man who runs it is accustomed to think in almost any other terms than dollars and cents.

Some of them can tell the horsepower of their engines or the output in kilowatt-hours; some even have an idea of the amount of steam or of coal used per horsepower or per kilowatt, but the man who can tell how much the power to produce a kilowatt-hour, or a case of shoes, or a bale of cloth, or a barrel of flour, or to provide elevator service and other conveniences for a thousand square feet of rentable office building costs is usually working for himself.

A man needs to have a higher point of view than is usually vouchsafed to the engineer-in-charge to be able to see at once all the factors which enter into this computation. He can, within the limited sphere usually accorded to him in the managerial mind, sometimes weigh the coal and measure the water and horsepower, but this makes him think in pounds of coal and steam per horsepower-hour. To think in dollars he must know the price of the coal, the cost of the equipment, the taxes and insurance, and every item which would not exist if there were no need of power. And if he is to reduce it to power cost per unit of output he must know the output too, and keep in touch with the business end.



The average engineer would expect to get fired on the spot if he asked the boss what his last month's output was, or what he was paying for taxes and insurance.

But would he?

Surely! if the boss thought he was snooping to get information for the benefit of a competitor, or to barter for his own present or future advantage.

But suppose the boss could know that he was simply seeking to expand his own knowledge of his own job so that he could run it better and cheaper; that he was interested as an engineer in beating out other engineers.

Don't you suppose that the boss would value more a man who could tell him how much more or less coal he burned this month than last, and why?

If he found you had ideas that meant money to him, don't you think he would be glad to talk them over with you? Get yourself cocked and primed, and then—

Put it up to the Old Man.

An Alabama Coal Mine Power Plant

Location of Boiler House on Hillside Enables Delivery of Fuel from Tipple to Stokers by Gravity. Ash also Disposed of in Novel Manner

BY WARREN O. ROGERS

One is apt to get weary of reading descriptions of power plants unless there are novel features incorporated in the design. Steam-turbine plants are built on similar plans, reciprocating-engine plants have been described for years, and it would almost seem that there are but few features that can be changed or applied differently in one plant that does not appear in another.

In the power plant of the Roden Coal Company, located in the town of Marvel, Ala., several features have been incorporated which are not found in the ordinary type of plant. This plant has recently been built for the purpose of supplying power for operating the coal-handling devices used in the mines. At first thought, it would seem that economy in coal-mine power plants would not be considered as of vital importance to the operation of the mine as a whole, but it is, and most mine power plants, which are located close to the mouth of the mine, are equipped with the best and most uptodate engine, boiler and necessary auxiliaries that can be procured. This important fact has been gradually dawning upon mine operators for some time, due to the gradual depletion of workable coal seams which has increased the cost of mining and loading on cars ready for shipment. Many have, in the past, looked upon the amount of coal burned under the mine boiler as not entering into the question of cost of production, but are now looking at the question in the right light, for each additional ton of coal consumed at the mine plant makes the cost of mining higher.

In order that the maximum amount of coal could be mined from a given area and at a minimum of cost and loaded on the cars ready for shipment at the least possible expense, this power plant has been built for handling the output of one of the company's mines. The present plant will be extended in the near future to handle a similar mine located about three miles distant; the present installation is housed under a structure having one end temporarily covered with a wood sheathing, as shown in the boiler-room view, Fig. 2.

FIG. 2. VIEW OF THE BOILER ROOM

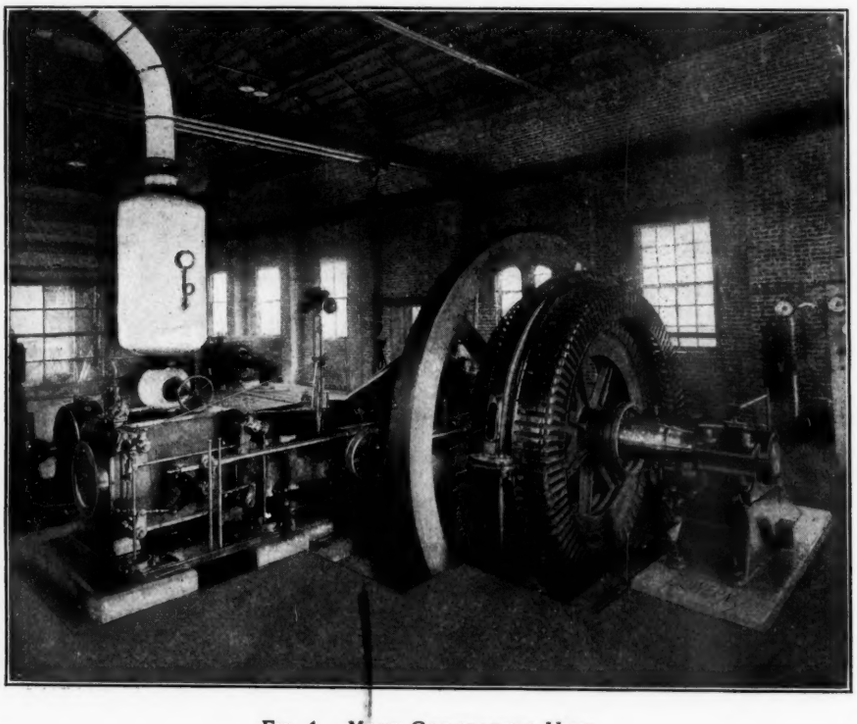


FIG. 1. MAIN GENERATING UNIT

ENGINES

In the engine room are installed a Hardie-Tynes 28x48-inch double-cylinder double-drum first-motion hoisting engine. The diameters of the drums are 8 feet, and each has a capacity of 5000 feet of 1¼-inch wire rope. The flanges of the drum have been made detachable for replacing with higher ones when longer ropes are required.

The engine is fitted with steam-operated brake, friction and reversing gear, as shown in Fig. 3. The cylinders are fitted with Corliss valves, but are operated without the usual cutoff gear, the point of cutoff being regulated by the link motion. Later on, when the length of haul has been materially increased, the dashpots and entire Corliss valve gear will be added.

This engine hauls fifteen cars out of the mine on a 27-per cent. grade, each car weighing, when loaded, 5000 pounds, and draws them out at a speed of 1500 feet per minute.

Another unit is a Westinghouse 125-kilowatt, direct-current, 125-volt generator direct-connected to a Sturtevant 8x7-inch engine operating at a speed of 350 revolutions per minute. This unit is

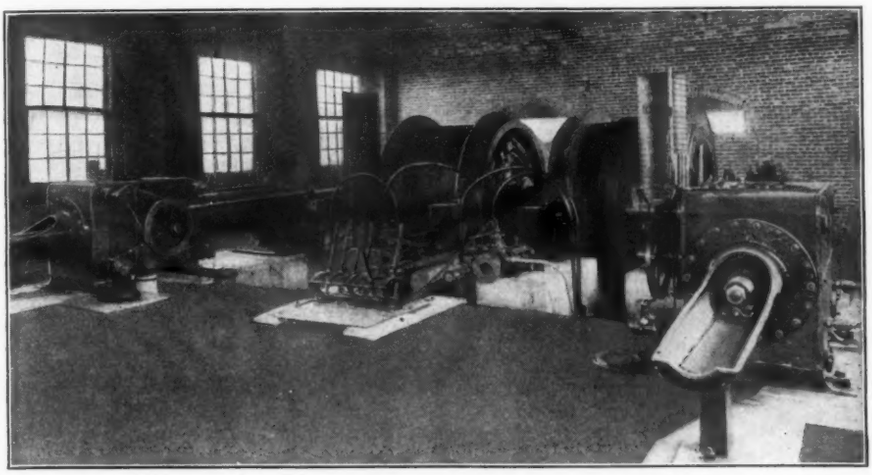


FIG. 3. THE MINE HOISTING ENGINE

The generating unit consists of an 18x 24-inch Hardie-Tynes Corliss engine, direct connected to a Westinghouse 250-kilowatt, three-phase, 60-cycle, 2300-volt generator, Fig. 3. The present load on the generator consists of Allis-Chalmers motors used for operating the machine and carpenter shop, mine-ventilating fans and tipple operation.

There is also one motor-generator set used as an exciter set, and is of sufficient capacity to handle additional power units.

There is also a Dayton three-stage turbine pump, driven by an Allis-Chalmers 35-horsepower motor. This pump is located at a water supply 500 feet distant from the power house and is handled by remote control. The pump operates against a total head of 300 feet and supplies water for the town of Marvel,

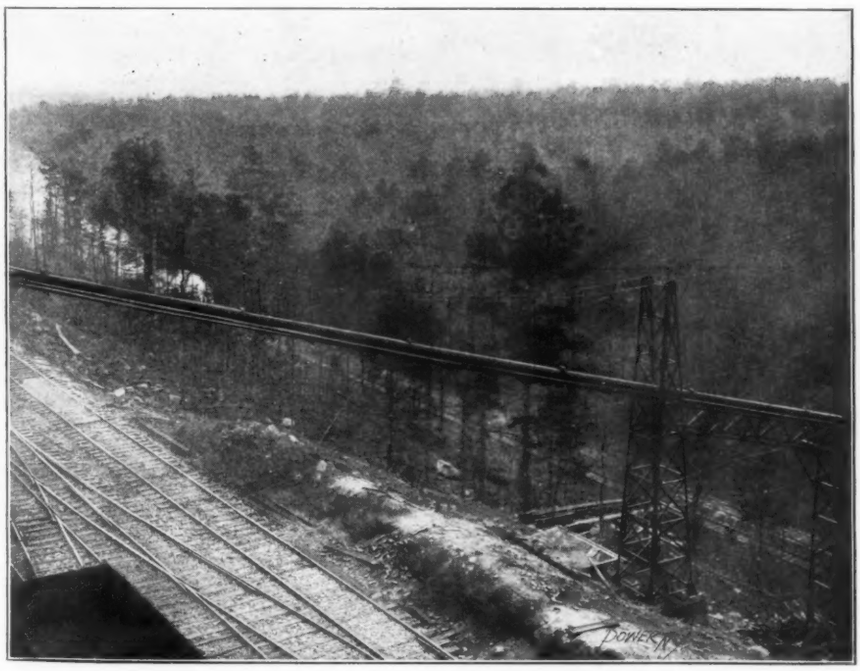


FIG. 5. PIPE LINE SUPPORT

comprised of a Westinghouse 112-horsepower motor driving a 75-kilowatt, 250-volt, direct-current generator which furnishes current to two mine-electric locomotives and two sinking pumps down in the mine.

as well as feed water for the boilers.

The reservoir for the former is shown in Fig. 4 and consists of a reinforced-concrete tank placed 60 feet above the ground on a tower of similar construction. For the boiler-feed water a 180,000-gallon reservoir was built on top of the hill immediately joining the power house.

BOILER HOUSE

The boiler house, as constructed at present, is 41 feet wide by 51 feet long, and is located on the hillside 79 feet below the engine house, and at a distance of 197 feet. It is built of brick with steel roof trusses and tile roof. This site was chosen because it gave an easy method of not only delivering the coal to the boiler room, but also made it possible to remove the ash at a minimum cost. The unwashed slack coal which is used for fuel and contains very high ash, is conveyed

FIG. 4. REINFORCED 50,000-GALLON WATER TANK AND TOWER

directly from the shaking screen in the breaker house on the tipple to a storage bin having a capacity of 250 tons. It is drawn off at the bottom through gates into a charging car, holding ½ ton of fuel. This car runs on a track having a slight grade in favor of the load and extends to and over the stoker hoppers in the boiler house.

Under the boilers is a similar track on which the ash car runs, and continues

out on the hillside on a light trestle work, where the ashes are dumped down the hill after being discharged from the ash car. Thus the handling of the fuel and ashes is a downhill proposition and eliminates many undesirable features in fuel and ash handling.

In the boiler room are installed three 300-horsepower Wickes vertical water-tube boilers. As shown in Fig. 2, each boiler is set separately. They are supplied with Murphy automatic stokers, and carry a pressure of 150 pounds per square inch. One man on each shift cares for the boiler plant which includes handling the fuel and ashes. The boilers are set on a concrete foundation made from a mixture of one part cement, three parts sand and five parts crushed rock.

The boiler-feed water is handled by a Wilson-Snyder pump, 8 and 5 by 12 inches stroke, of the outside duplex type and automatically governed.

Piping

The steam pipes are all of full weight with van-stone joints. The pipe connections connecting the boilers to the headers are made with long-radius bends and the header is suspended from roof trusses in addition to pipe-column support.

A 12-inch main supply steam pipe runs from the boiler house to the engine house, and is supported on a suspension bridge, as shown in Fig. 5; this illustration also gives an idea of the slope of the hill. The expansion and contraction of the pipe are taken care of by a Harter flexible joint placed at the junction of the main steam pipe and header. The main steam pipe is attached to a long-radius cast-steel ell at the point where it enters the power house. This ell is securely anchored to a concrete foundation. From a tee connecting to the top of the ell, a 10-inch pipe branches off to supply steam to the hoisting engine, and an 8-inch pipe extends in the opposite direction to the engine operating the generators. In the basement, under the engine room, are placed all piping, steam traps, etc., together with the throttle for the hoisting engine, the steam passing through a 32x72-inch Swartwout receiver separator. The generating engine is equipped with a similar receiver, but of a trifle smaller dimensions.

The writer is indebted to Thornton Brothers, engineers, for photographs and data.

Indicators for Hoisting Engines

A small insignificant-looking device which plays a most important part in mine hoisting and other work of similar character, is the indicator, which tells the engineer when the cage, bucket, or whatever is attached to the hanging end of the rope, is at its landing place.

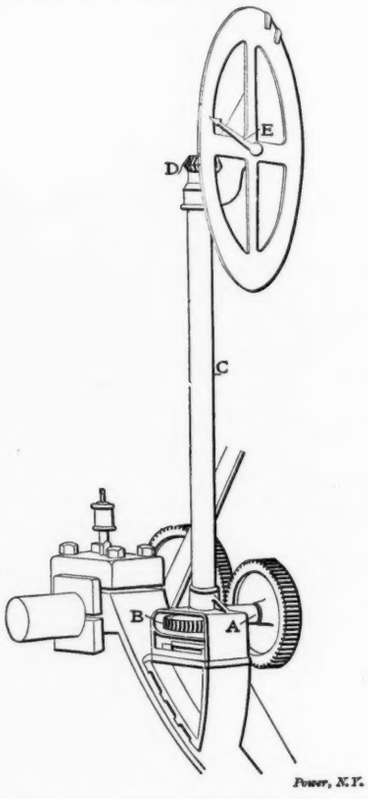


Fig. 1. Common Type of Indicator

Perhaps the most common type is the dial indicator, shown in Fig. 1. A gear wheel is fitted to the drum shaft, and meshes with a smaller gear securely fastened to a worm shaft, as at *A*. This worm meshes with a worm gear *B* which is keyed to a vertical shaft on the interior of the casing *C*. On the top of this vertical shaft is a beveled gear *D*, which meshes with another bevel gear attached to the shaft on which the dial pointer *E* is fastened.

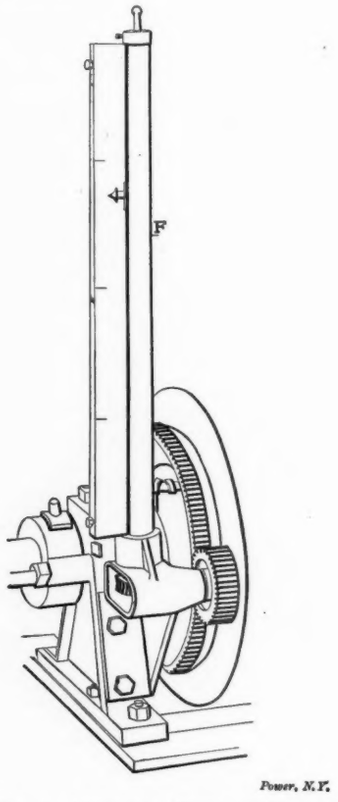


Fig. 2. Vertical Type of Indicator

The dial is marked in feet by tens, twenties, etc., according to the depth of the shaft, while each landing place or level is indicated either by a red or black arrowhead or similar design. The combination of gears, worms, etc., is so accurately designed that the pointer revolving around the dial indicates the exact amount of rope unwound from the drum, and the exact position of the cage. When the engineer is hoisting or lowering the cage, it is this indicator that claims his attention.

A vertical type of indicator is shown in Fig. 2. It is geared similarly to that shown in Fig. 1, but the indicating arrow is secured to a movable piece, threaded on the inside and moved up and down on a threaded shaft concealed in the vertical shaft *F*. Back of the indicating arrow is an indicating board so graduated that when the pointer indicates the figure, say 500, there are 500 feet of rope unwound from the drum.

Another indicator of similar design is shown in Fig. 4, but is of the horizontal type, and is operated by means of a sprocket chain instead of gears. The two indicating pointers travel from one end of the threaded shaft to the other, ac-

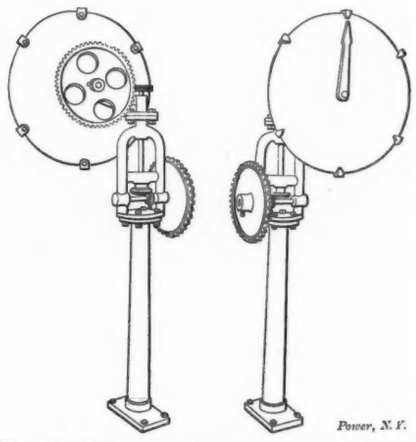


Fig. 3. Rear and Front View of Single Dial Indicator

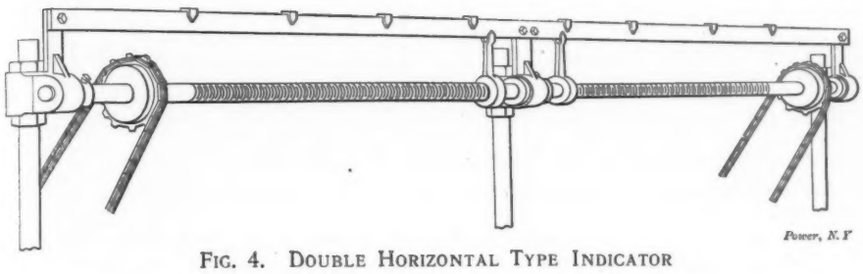


FIG. 4. DOUBLE HORIZONTAL TYPE INDICATOR

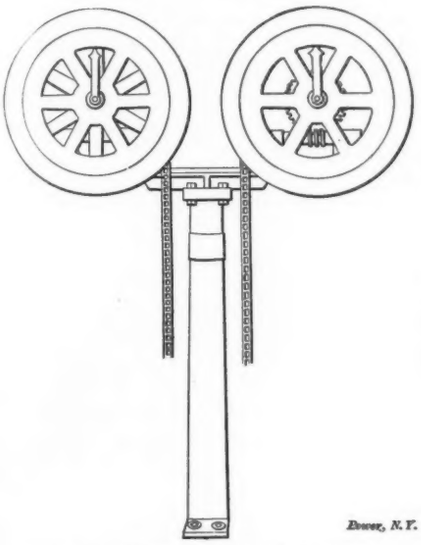


FIG. 5. DOUBLE DIAL INDICATOR

cording to the direction of the winding-drum rotation. This design is for double-drum work.

A rear and front view of another design of single dial indicator is shown in Fig. 3. It is chain driven and the dial can be set to face in any direction without changing the position of any other part. The landing indicating points are movable on the dial to any position desired.

The sprocket wheel is attached to a shaft on which is a bevel gear. This gear meshes with another on the vertical shaft, on which is a worm gear. This worm gear engages with another worm gear attached to a shaft on which is fastened the indicating pointer.

Another type of dial indicator is shown in Fig. 5. It is a double-dial differential indicator for deep shafts. The outside dial makes 22 revolutions to one of the inside dial, while the pointer remains stationary. It is designed for use when hoisting at a high rope speed and indicates the position of the cage with great accuracy.

An over-winding bell signal is shown in Fig. 6. It consists of a dial on which two large gongs are attached, two adjustable arms, the adjustable feature being for the purpose of timing the striking of the hammer on the gong proper. The hammer *A* is tripped by the pointer *B*, which is operated by a worm gear connected to the winding drum similar to the method shown in the foregoing. It is used on balance bucket hoisting, so that when the pointer is moving toward the left, the hammer will strike the gong after

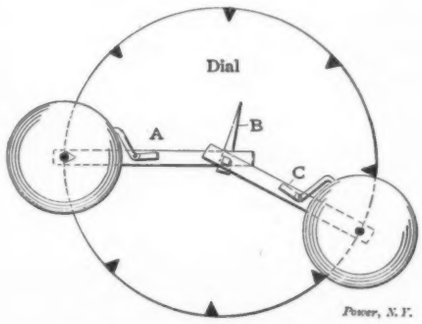


FIG. 6. OVER WINDING ALARM

the pointer *B* lifts and releases it, when the load is about 10 feet from the top. The gong *C* rings with a reverse motion, or when the load is within 10 feet of the bottom.

The end of the hammer is attached to the main part of the hammer proper by a thin spring which acts as a hinge and allows the pointer to pass the hammer on its return movement.

A New Formula for the Total Heat of Saturated Steam

As has been pointed out in POWER several times lately, modern investigations with more refined methods and apparatus have determined the physical properties of saturated steam with more accuracy than they are given in the usual tables based upon Regnault's determinations. The fact that serious errors existed in the accepted tables in respect to the total heat of steam was pointed out by Dr. Harvey N. Davis of Harvard University in a paper presented to the American Society of Mechanical Engineers in December, 1908. As a consequence of this demonstration Professor Peabody revised his well known steam tables, and Professors Davis and Marks issued a new set of tables, both having been reviewed in POWER for August 31, 1909.

Working with the new values of Davis and Marks, Robert H. Smith has evolved a formula which is presented in *Engineering* (London) of December 24, showing very simply the relation between temperature t and total heat H.

$$H = 1826 + t - \frac{1{,}250{,}000}{1620 - t}.$$

RULE: *Divide* 1,250,000 *by the difference between* 1620 *and the given temperature.*

Add the given temperature to 1826.

The difference between the two values so found will be the total heat in British thermal units.

Example: Let the temperature be 250 degrees, then

$$H = 1826 + 250 - \frac{1{,}250{,}000}{1620 - 250}.$$

$$1620 - 250 = 1370$$
$$1{,}250{,}000 \div 1370 = 912.4$$
$$1826 + 250 = 2076$$
$$2076 - 912.4 = 1163.6$$

The following table gives values calculated from this formula, and compares them with those of Professor Marks' new tables.

Temperature, Fah.	Pressure, Lb. per Sq.In.	Formula, H.	Marks, Table H.	Difference.
30	0.081	1069.9	1072.6	—2.7
50	0.178	1079.8	1081.4	—1.6
60	0.256	1084.7	1085.9	—1.2
70	0.363	1089.6	1090.3	—0.7
80	0.505	1094.3	1094.8	—0.5
100	0.946	1103.6	1103.6	0
150	3.71	1125.7	1125.3	+0.4
200	11.52	1145.7	1145.8	—0.1
250	29.82	1163.6	1163.8	—0.2
300	67.0	1179.0	1179.1	—0.1
350	134.6	1191.8	1191.5	+0.3
400	247.1	1201.4	1201.3	+0.1
450	421.0	1207.6	1208.0	—0.4
500	684.0	1209.9	1209.0	+0.9
600	1574.0	1200.5	1176.0	+24.9

The small + and — differences indicate, of course, that these are within the range of probable error in the tabular figures. This means that from about 70 degrees or 80 degrees to about 500 degrees the agreement is complete.

The fact that 1,250,000 is ⅛ of 10,000,000 makes it possible to transpose the formula to

$$H = 1826 + t - \frac{10{,}000{,}000}{12{,}960 - 8t}$$

12,960 being 8 × the 1620 of the formula in the other form. It is now necessary to subtract 8 times the given temperature from 12,960, look up the difference in a table of reciprocals, and subtract the tabular value, changing the decimal point to multiply by 10,000,000, from the sum of 1826 and the given temperature.

India rubber melted by a gentle heat, 6 to 8 per cent. by weight of tallow; keep well stirred; allow to stand for 24 hours; then add dry slack lime until the mixture assumes the consistency of soft paste; then add 20 per cent. of red lead in order to insure perfect hardening. This cement will be proof against boiling acids.

Uncle Pegleg's Philosophy

I Learn Something about Coal and Its Poor and Rich Relations; and Obtain Some Idea of the Large Amount of Energy Stored up in a Small Pound Lump

One day as I went into the engine room sometime before noon to set my pail of coffee on the cylinder to warm, I found Uncle Pegleg looking at a lump of coal through a magnifying glass. He was still holding it when I came back at noon.

"What's funny about the coal?" I asked.

"Nothing about that particular piece," he answered. I picked it up on the siding as I came in. But, when you come to think of it, coal is about the funniest stuff on earth anyhow."

"How so?"

"Well, what is it, to start with?"

"Why, it's a black rock that they get out of the ground, and a man in Philadelphia found that it would burn and nearly got put into jail for trying to sell some of it." These impressions were the net result of a story that I had read somewhere.

The old man laughed. "What you've got in your head, however it came there, is the story of the discovery of Pennsylvania anthracite. Coal had been known and used in the old country for years; it was one of the first uses steam was put to, pumping out coal mines; but early in this century (1803) they tried to ship Pennsylvania anthracite to Philadelphia, and couldn't burn it, so they used it for making walks instead of gravel.

"The first coal was charcoal that men made themselves out of wood. Then they found that nature had been

"WHAT'S FUNNY ABOUT THE COAL?" I ASKED

doing the same thing for them, for this 'black rock,' as you call it, is nothing but vegetable matter made by heat and pressure into this black solid lump. Why, they find prints of leaves and petrified tree trunks and all sorts of things in it. A Frenchman has made wood into hard coal by keeping it under water at something like 750 degrees."

"I thought water boiled at 212 degrees and you couldn't get it any hotter."

"It boils at 212 degrees with the pressure of the atmosphere on it. It would boil at less than 32 degrees if there wasn't any pressure on it, and you can heat it to any temperature you please by putting pressure enough onto it. Look here," and he got out his engineers' bible and showed me the table, pointing out that at 14.7 pounds pressure, the usual pressure of the atmosphere at sea level, the boiling point was 212 degrees, while if the pressure were reduced to one pound it would boil at 102.1 degrees and at 0.089 of a pound it would boil at 32 degrees.

"Gee," I said, "it would be boiling and freezing at the same time."

"No, it wouldn't, for the freezing point would change too but we will have that out some other time. We are on the coal question now, and I was telling you how nature made it out of her waste vegetable matter. Ever see a peat bog?"

I had seen bogs but I didn't know whether they were peat or not.

"More than likely," insisted Uncle Pegleg. "You take a swamp and the stuff keeps growing and dying down and packing in year after year and it is under water so it don't decay and it just cooks up into a sort of muck that you can burn when you squeeze the water out of it, and that's peat.

"Well, now, something happened and some of those peat bogs got caught in between some rocks when the earth's surface wasn't as settled as it is now, and given a gentle squeeze, and years after somebody uncovers a bed of brown coal or lignite. There you've got your two steps, peat, lignite; and if you go on you land something like this: peat, *lignite*, BITUMINOUS COAL, ANTHRACITE COAL, GRAPHITE, *DIAMONDS*."

"Do you mean that the graphite that we dope the gaskets with and diamonds and coal are all the same thing?"

"Well, they're not the same thing exactly, for you can't buy diamonds at three dollars a ton; but they are all different forms of carbon, and if you had heat and pressure enough and knew how to use them you could probably make the higher rarer forms out of the cheap and common ones."

"I'd like to be able to make a load of diamonds out of a load of coal."

"Yes. But the coal is pretty curious stuff itself. There's that piece weighs, I suppose, about a pound. Do you know it has got energy enough stored up in it to throw its own weight over two thousand miles up into the air? Not feet but miles."

Taking this statement in connection with those about diamonds and graphite being the same thing as marsh muck, I began to think the old man was getting dippy. I must have looked incredulous for he said:

"Giving it to you rather fast, am I? Well, sometime you come up to the house and I will show you samples all the way up from bog peat to diamond, and you can see easier how they grade into each other, and I will show you some pictures of leaf prints, etc., in coal. My diamond is a black one such as they use in drills, but that makes it easier to see the connection. What do you know about heat?"

"Nothing special."

"Well, you know that less than a hundred years ago folks thought that heat was a sort of a juice, an 'igneous fluid' that was squeezed out of a body by impact or compression. They knew that if you put a piece of iron on an anvil and hammered it it got hot, and they thought the heat was squeezed out of its pores. Bacon and Locke had both said that it was energy in the form of motion among the molecules, but they shot over the people's heads, talked and wrote so that only a few of them knew what each other was talking and writing about."

"What's molecules?"

"A cubic inch of water will make 1646 cubic inches of steam at atmospheric pressure. One cubic inch of water expands into nearly a cubic foot of steam. If it was all one continuous mass in the liquid form it can't be so in the steam form. Mass can't swell like that. It means that the water is made up of little particles called molecules, and these again are made up of atoms. Two atoms of hydrogen and one atom of oxygen make a molecule of water. That's why they call it H_2O. These atoms and molecules are like little suns and planets whirling around each other. Every particle of matter attracts every other particle, just as the earth attracts a stone when you drop it. There's no up and down in nature. If you and a Chinaman on the other side of the earth each drop a stone at the same time the stones will fall toward each other, both trying to get to the center of the earth. The earth attracts the moon. That's what keeps it from flying off into space. The moon attracts the earth too, just as hard, another case of equal and opposite as I showed you the other day when you tried to pull me out of the chair. The reason that the moon and earth don't rush together is that they are in motion around each other, and their centrifugal force keeps them apart. These little atoms and molecules attract each other the same way, and it is their motion that keeps them apart. They are many times their own size apart even when the body that they are parts of is solid. If you could be on an atom in the middle of a brick you would see the other atoms and molecules around yours, like you see the stars and planets around the earth."

"Gees! if a solid is made up as loose as that you'd think it would fall apart."

"Know how much it would take to pull a rod of boiler steel one inch square apart?"

I shook my head.

"About 60,000 pounds. A rod one inch square of good boiler steel will just about hold up a weight of thirty tons. And what is doing it is the magnetism, the attraction, between these little molecules already wide apart. When you break the bar you have just overcome the attraction between the molecules that you expose in the plane of fracture."

"Was it these molecules you was trying to see with the magnifying glass?"

"Bless you, no. There's no microscope can bring them out. Know how big the earth is?

"About 8000 miles in diameter."

"How many feet is that; about 42,000,000, isn't it?" (Making a pass on a slide rule that he always carried in his coat pocket.) "Well if you took a ball of matter a foot in diameter and magnified it up to the size of the earth, that is until its diameter was 42,000,000 times the original size, the atoms and molecules would be somewhere between buckshot, and good-sized cannon balls.

"Now heat is just the energy in those moving particles. Here is this piece of coal that weighs say a pound. If I put it up onto the bench it will have about three foot-pounds more energy in it than it has when it lies on the floor. It is three feet further away from the earth's center and so possesses the possibility of doing three foot-pounds of work for each pound of its mass in descending to the floor. I could tie it to a cord and make it run a clock or a little fan. It doesn't look any different on the table from what it does on the floor, feels just the same; but it has got that much more energy stored up in it just the same, it has got that amount of latent possibilities, it is capable of doing, *potent* to do, that much more work; and that kind of energy, that energy which bodies possess by reason of their relative position or separation is called 'potential' energy.

"Suppose you took this piece of coal and threw it straight up in the air, how high could you make it go?"

"Fifty feet," I answered confidently.

"I don't think so, but suppose you could. When it got up to the top of its course it would have, supposing it weighs a pound, fifty foot-pounds more energy in it than it had when it left your hand. You put fifty foot-pounds of energy into it when you got it into motion. At the instant that it stands there fifty feet above the point that you re-

leased it it has fifty foot-pounds more of *potential* energy in it. But it and the earth have been pulling each other all the time, and this pull has been inducing motion downward. If you can imagine two motions going on at once, the coal commences to fall the instant that it leaves your hand, and when the downward motion which it gains is equal to the upward motion that you gave it, it will stop, and as the growing downward motion exceeds the motion of your throw it will come back faster and faster. When it has fallen ten feet it will have only forty foot-pounds of potential energy in it; the other ten pounds will have been changed back into energy of motion; and when it gets back to your hand it will have no potential energy in it over what it had when you threw it, but it will be going pretty fast, and all the potential energy will be changed to energy of motion. You can see and feel the effects of this kind of energy. It would be likely to hurt you if it hit you. This kind of energy is 'sensible' to us, apparent to our senses. They call it 'kinetic' energy, from a Greek word meaning 'to move.' When the molecules of a substance have more of this kind of energy the substance feels hotter to us; when they have less it feels cooler. That is what one kind of heat is, the energy which is stored up in the molecules of a substance due to their motion."

"But," I argued, "you say this lump of coal has energy enough in it to chuck itself up in the air a couple of thousand of miles and yet it isn't as hot as this piece of pie that hasn't any energy at all."

"Yes, it has, and the reason that you are eating it is that you may soak up some of its energy and be able to walk and think and work. That pie might furnish the very fifty foot-pounds of energy that you put into the coal if you chuck it into the air. I'll tell you later how it's stored up in the coal—and the pie; and how we get some of it out and use it. You'd better look her over now. That main bearing's been cutting up again this morning."

The Chemist's Place in Power Economy

The watchword of modern industry is no longer "increased production;" it has changed to "increased efficiency of production." The day of cheap raw material is passing, if indeed it has not already gone, and industry faces a new set of conditions. Nowhere more than in the production and transmission of power are there greater opportunities for improvement—for the saving of time, and labor, and money. That the chemist ought to take the foremost part in solving the problems of power efficiency is the argument convincingly set forth in a paper read before the recent convention of the American Chemical Society, by Arthur D. Little, of Boston. Mr. Little makes a vigorous presentation of the chemist's special qualification for dealing with questions of energy, and urges a stand against the customary monopolizing of power problems by the mechanical engineer.

Chemists sometimes forget, says Mr. Little, that their science deals with energy no less than with matter, and that in fact chemistry as a science began with the recognition of the principles, materials and products of combustion. They have allowed the mechanical engineer to usurp many things which properly come much more directly within their own province.

The combustion of coal is a typical chemical process. The selection of the most efficient coal and the determination of the conditions necessary for its most efficient combustion are essentially chemical problems. Chemical problems also are those arising in the manufacture of producer and illuminating gas, their utilization in gas engines, the development of power from the waste gases of the blast furnace, the adaptation of conditions to the proper handling and burning of peat, lignite and waste coal, the thermometric exploration of coal piles to forestall spontaneous combustion, smoke abatement, the control and improvement of fire-room conditions by draft regulation, flue-gas analysis, temperature measurements and even the placing of firemen on the bonus basis. Taking power-plant practice and the conditions of coal purchase as they stand, the properly equipped chemist should be able to increase the efficiency of power production from 5 to 30 per cent.

The analysis of boiler compounds as an end in itself presents little to excite enthusiasm, but when such analyses are made the means of saving $3600 a year in the power plants of a single company they take on a new and larger aspect, not only in the mind of the chemist but in the mind of the chemist's client.

The chemist who attacks the problems of power production will not hesitate to go outside the laboratory and take his property wherever he finds it. He will conduct boiler and engine tests, study the efficiency of grates and stokers, familiarize himself with the marvelous promise of the low-pressure turbine as an agent in efficient power production. While straining every resource of his science to produce steam economically by the combustion of coal, is it common sense for the chemist to stop there in ignorance of the fact that the efficiency of that steam can be increased at once from 25 to 100 per cent. by coupling a turbine to the exhaust?

The distribution of power supplies problems no less directly within the province of the industrial chemist. He may begin with the analysis of lubricating oils. He proves his own inefficiency if he stops there. He must inform himself regarding the market prices of oils used elsewhere for similar service, the adaptability of the oils in question to application to the bearing by soaked waste, sight feeds, or gravity cups. He must be prepared to interpret his analysis in terms of practice, and to follow the oil through the plant in order to prescribe conditions which shall keep down waste. There are few plants in which the industrial chemist working along legitimate lines cannot save from 20 to 60 per cent. of the entire lubrication account, while the oil analyst has to his credit merely a few figures which his client probably fails to understand.

The efficiency and life of bearing metals vary over an extraordinarily wide range. Some are merely the refuse from type foundries; others are so carefully adapted in their composition to the requirements of particular service as to show an efficiency 15 times or more as great as that of inferior material. Here again the mere analysis means little.

Much additional might be said regarding the opportunity before the chemist when any material concerned in power transmission is the subject of his study, whether it be leather, rubber or canvas belting, belt dressings, insulating material, trolley wire, trolley cars or trolley wheels. In every case it is within his power to create new standards of efficiency.

The Commonwealth Edison Company of Chicago and the General Electric Company of Schenectady have jointly presented to the department of electrical engineering of the University of Illinois, a 125-kilowatt steam turbo-generator. The turbine of this unit is to be noncondensing. The generator is to be designed for three-phase, 60-cycle currents, to be delivered at 2300 volts. With the addition of this machine the electrical laboratory will be prepared to deal extensively with problems involving single-phase, quarter-phase, and three-phase currents. The significance of this announcement is increased by the fact that this turbo-generator, which is secured for the university through the interest of the Commonwealth Edison Company, constitutes the first large gift which thus far has ever been received by the College of Engineering. This gift following closely, as it does, after the coming to the university of Dr. E. J. Berg as professor of electrical engineering, may be accepted as marking a new era in the activities of the department of electrical engineering at the University of Illinois.

Test of Triple Expansion Pumping Engine

This pumping engine is of the vertical triple-expansion crank and flywheel type, having three single-acting pumps, the engine being entirely self-contained above the pump chambers. There are two receivers, one between the high- and intermediate- and one between the intermediate- and low-pressure cylinders. No reheating steam coils are used in these receivers. The valve gear is of the Corliss type on the high-pressure and the intermediate-pressure cylinders. Both steam and exhaust valves on the low-pressure cylinder are of the single-beat poppet type operated by cams working against disks secured to the valve stems. Separate steam and exhaust eccentrics mounted on the main

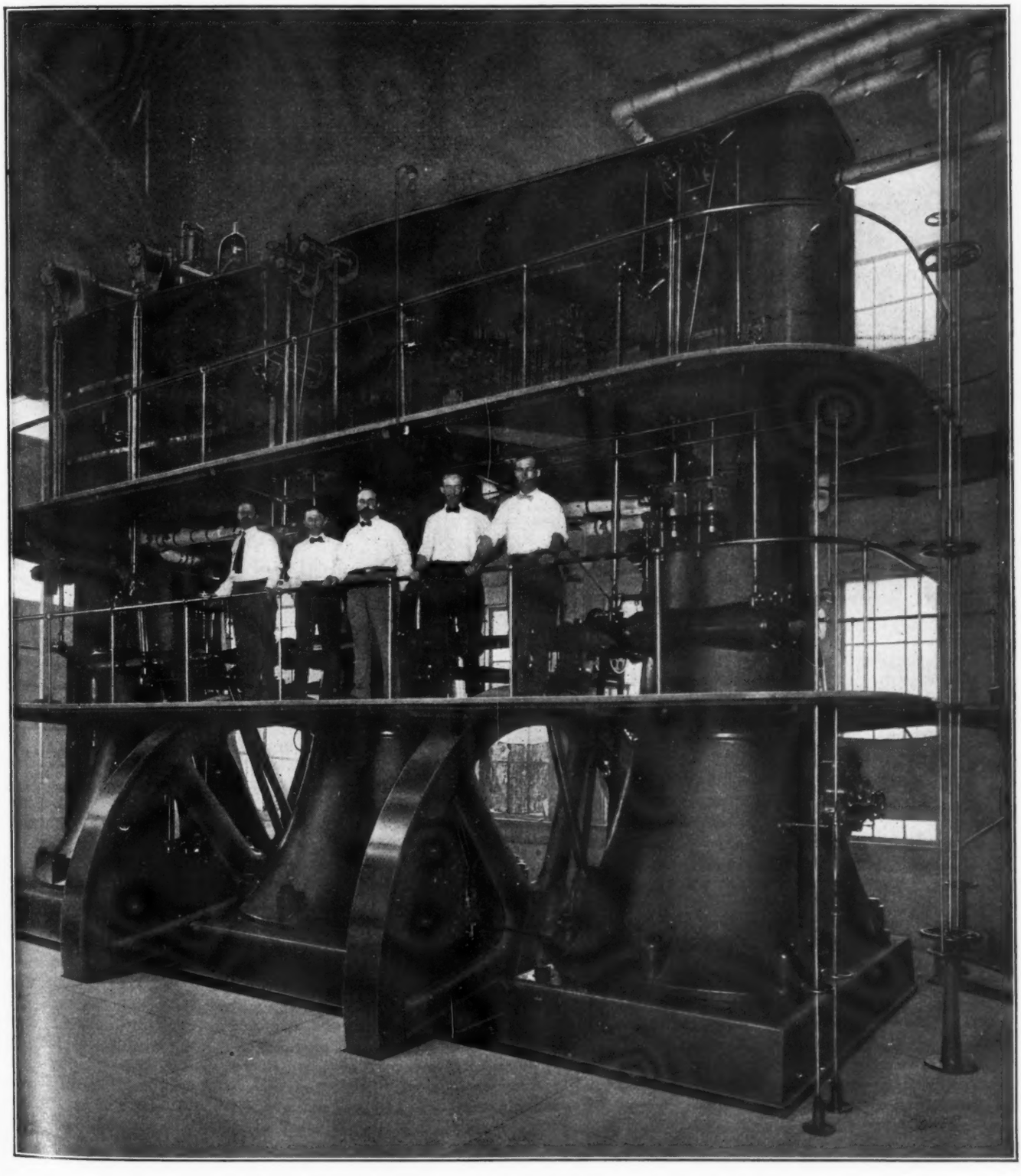


FIG. 1. TRIPLE-EXPANSION PUMPING ENGINE, SAN ANTONIO, TEXAS

shaft of the engine are used for driving the valve gear. The high-pressure cutoff is controlled by a flyball governor which is equipped with adjusting spring mechanism, which provides for varying the speed over a wide range while the engine is running. The intermediate-pressure cutoff is hand-adjusted while the low-pressure cylinder valves are definitely set and are not subject to change while the engine is in operation. The general appearance of the engine is shown in the illustration, Fig. 1. The three pumps are located underneath and in line with the steam cylinders, and are of the single-acting, outside-packed plunger type of 48-inch stroke and 30.5 inches in diameter. The surface condenser, having 1500 square feet of cooling surface, is in the suction main. The total water pumped by the engine passes through the tubes, and the exhaust steam around them. The air pump is 22 inches in diameter by 48 inches stroke, and is connected to an arm on the low-pressure plunger.

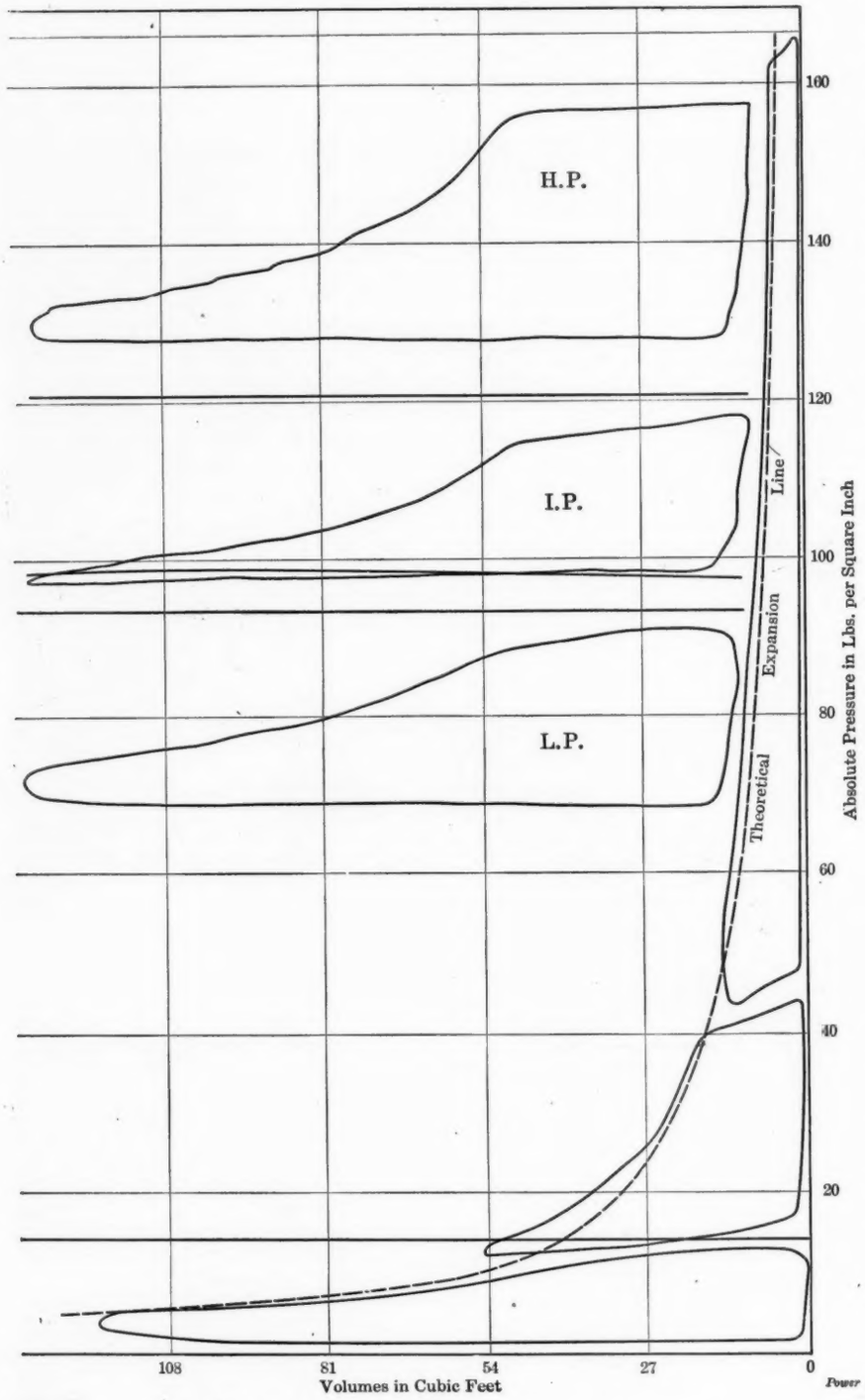


FIG. 2. SEPARATE AND COMBINED INDICATOR DIAGRAMS

The corrected net steam pressure at the throttle during the test, taken at ten-minute intervals throughout the twelve hours, was found to average 152.22 pounds per square inch. The quality of the steam supplied to the engine was determined at hourly intervals by means of a Carpenter throttling calorimeter, the average result being 0.925 per cent. moisture. The total weight of the steam used by the engine during the twelve-hour test was 91,525.64 pounds, of which 1876 pounds was low-pressure jacket and drain discharge. This gives an average value of 7627.13 pounds total consumption per hour, or 7556.58 pounds of dry steam per hour. The amount of dry steam used by the engine for all purposes per indicated horsepower per hour was 10.57 pounds, or the equivalent under the conditions of pressure employed of 199.3 B.t.u. per indicated horsepower per minute.

The indicated horsepower of the engine under test conditions calculated from 149 sets of diagrams was 714.6 divided between the cylinders as follows:

High pressure	266.4
Intermediate	210.1
Low pressure	238.1
Total	714.6

A set of typical diagrams and a combined diagram is shown in Fig. 2.

The engine was built by Allis-Chalmers Company for the San Antonio Water Supply Company, San Antonio, Tex. The cylinders are 26, 50 and 74 inches in diameter and have a common stroke of 48 inches. We are indebted to Prof. A. C. Scott, University of Texas, Austin, Tex., for a report of the tests.

Thursday evening, January 20, James L. Ford, of the Hartford Steam Boiler Inspection and Insurance Company, gave an illustrated lecture on Boilers and Boiler Explosions, before the Society of Brewing Technology, in the rooms of the Western Society of Engineers. Mr. Ford first showed what enormous energy was confined in a steam boiler of ordinary proportions, and explained what a vast amount of destruction was possible when a boiler fails. To the question of "What makes a boiler explode?" he quoted the classic answer of "Not strong enough to stand the pressure," and said that in constructing boilers they should be made sufficiently strong not only to withstand the pressure, but also be so constructed as to endure a certain amount of abuse, such as boilers are subjected to in ordinary operation. The growing tendency to large-size units, Mr. Ford thought, was opening up possibilities of unequal expansion and contraction, which are very undesirable from the standpoint of safety. Views were shown tracing boiler development from the time of Watt, and giving examples of all the leading makes of water-tube boilers, with their distinguishing characteristics. Following this an account was given of several destructive boiler explosions.

Economical Velocities in Steam Piping

Friction and Radiation Losses in High-pressure Steam Piping with Charts Showing the Most Economical Steam Velocities and the Corresponding Size of Pipe Required

BY PERRY WEST

In designing anything, it is generally well to start with the figures or calculations, and with piping it is the approximate sizes which are needed first. With these sizes well in mind, the scheme may be laid out; after which the final plans and details may be completed. The preliminary sizes are determined by using the commonly accepted velocities of flow, which are usually quite accurate enough for this purpose. For preliminary pipe sizes and layouts, the following velocities may be used: 6000 feet per minute and 8000 feet per minute for saturated and superheated steam respectively. From the pipe sizes thus obtained, the amount of space to be occupied by the piping, together with its general arrangement and provisions for flexibility may be approximated.

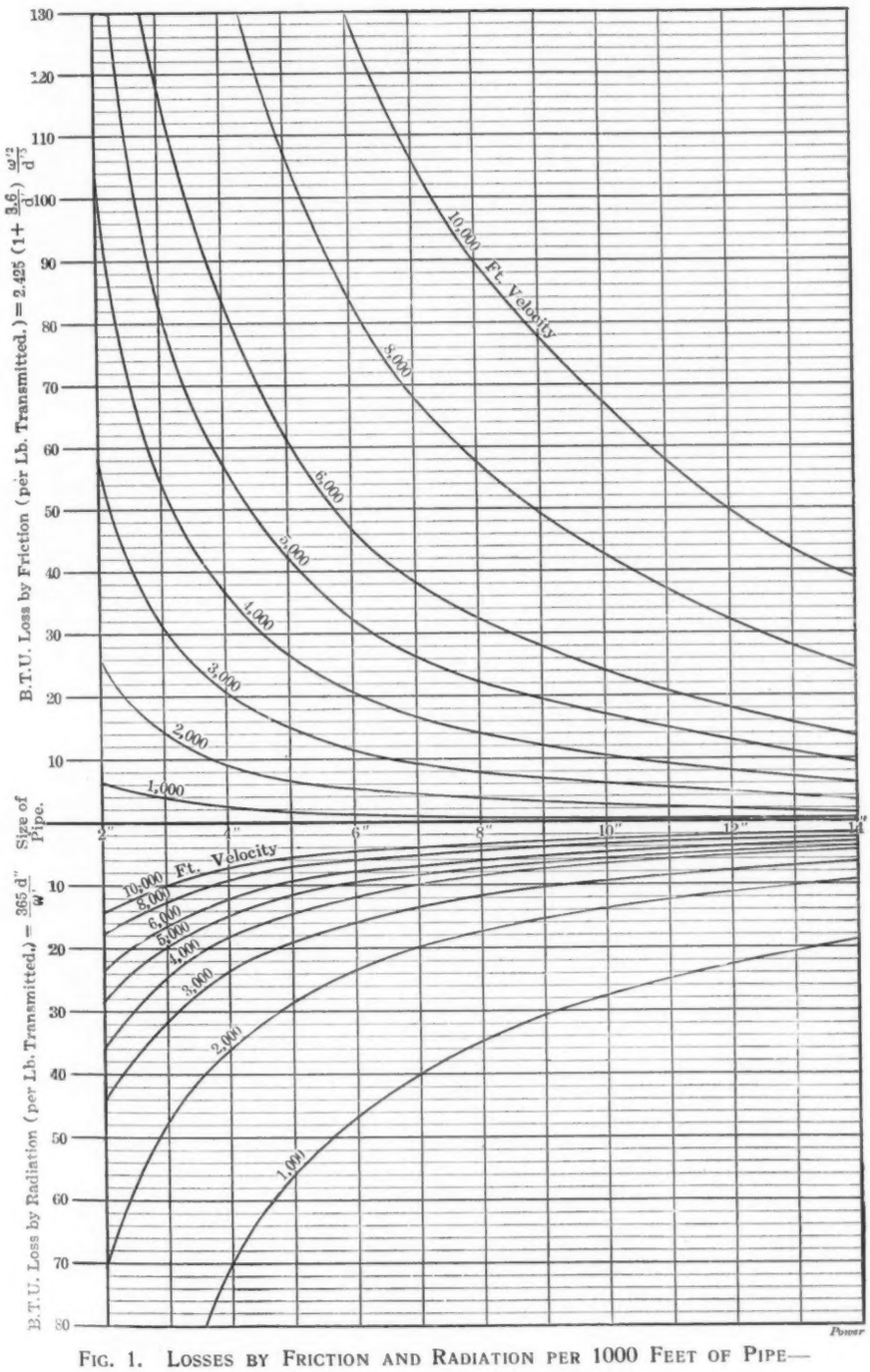


FIG. 1. LOSSES BY FRICTION AND RADIATION PER 1000 FEET OF PIPE—NONCONDENSING CONDITIONS

The economical size for any pipe is that at which the sum of all losses and charges is a minimum. Generally speaking, these losses and charges consist of those from friction, radiation and fixed charges. Losses from velocity head will be neglected here, due to their comparative insignificance.

LOSS FROM FRICTION

Of the frictional loss we are principally interested in the drop in pressure which this may cause at the end of the line, and its consequent detriment to efficiency. The heat of friction, which should be equivalent to the energy lost in friction, has some value toward the offsetting of this loss. In other words, this heat may either wholly or partially counteract the condensation in saturated steam lines, or it may add to the superheat in superheated lines. The reduction of pressure may also otherwise tend to superheat the steam due to wiredrawing. Properly speaking, this additional heat should be credited against the frictional losses, but with the present status of experimental data, this is impracticable. Of the experiments noted, those for the determination of frictional drop in pressure do not seem to comprehend the corresponding temperature changes; nor do those for determining temperature changes comprehend the corresponding frictional drop in pressure. An exhaustive series of experiments determining the corelation of these factors and at the same time eliminating the effects on same of the heat transfer through the walls of the pipe would be a very welcome link in the scientific study of pipe sizes. For the purposes of this paper no further account will be taken of this heat of friction except to say that in the absence of exact data, it may at least be borne in mind as a factor in favor of higher velocities than might otherwise be selected.

The accepted formula for expressing the friction head in steam pipes may be written as follows:

$$H' = f \frac{2\,v^2}{g\,d\,W\,L'}$$

where

d = Diameter of pipe in feet,

L = Length of pipe in feet (or L' its equivalent in effective length, when ells and globe valves are included),

v = Velocity in feet per second,
W = Pounds of steam flowing per hour.

This friction head may be reduced to pressure in pounds per square inch,

$$p = 0.000131\left(1+\frac{3.6}{d'}\right)\left(\frac{w' L}{D\, d'^{5}}\right), \quad (1)$$

where

p = Frictional loss in pounds per square inch,
D = Density of the steam in pounds per cubic foot,
d' = Diameter of the pipe in inches,
W = Pounds of steam flowing per hour,
W' = Pounds of steam flowing per minute.

The frictional drop through easy bends, such as standard pipe bends, may be taken equal to that through the same length of straight pipe. The drop through standard radius ells and through globe valves may be taken as equivalent to that through a certain length of straight pipe. In figuring the drop through a pipe line, including bends, ells and globes, it is necessary, therefore, to increase L by an amount equal to the length of bends plus an equivalent for the ells and globes. This equivalent is given from the latest experiments as follows:

For 90-degree ells,

$$520\, d \div \left(1+\frac{3.6}{d}\right).$$

For globe valves,

$$706\, d \div \left(1+\frac{3.6}{d}\right),$$

where d = diameter of pipe in inches.

The L' used in succeeding formulas shall be understood to include these additions and may be termed the effective length in place of the actual length of the pipe line under consideration.

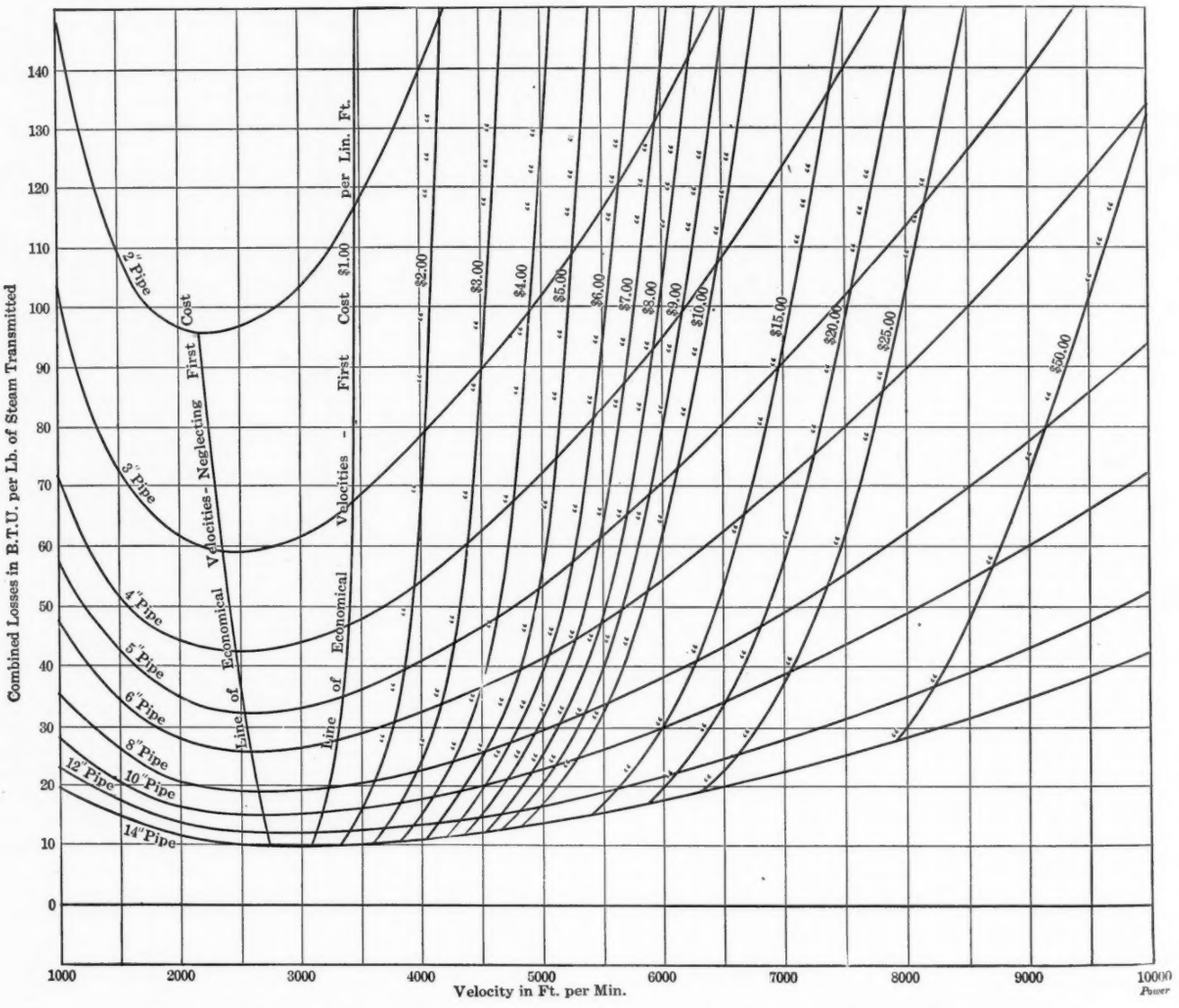


FIG. 2. FRICTION AND RADIATION LOSSES PER 1000 FEET OF PIPE—NONCONDENSING CONDITIONS

RADIATION LOSSES

The radiation losses in B.t.u. per hour may be represented by the following formula:

$$U = \pi\, d''\, L\, c\, (T_s - T_o),$$

where

d'' = Outside diameter of pipe in inches,
c = Constant,
T_s = Temperature of steam,
T_o = Temperature of the room.

For 2½-inch 85 per cent. magnesia covering applied in two standard layers according to the best practice, c may be taken equal to 0.35. The character of insulation will, of course, determine the value for c in each particular case. It may be taken to vary inversely as the square root of the thickness of the insulation. This value of 0.35 for c gives a corresponding value for

$$U = 0.09\, d''\, L\, (T_s - T_o). \quad (2)$$

FIXED CHARGES

These may be considered as being composed of interest, depreciation, taxes and maintenance. The proposed life of the piping, its character, and the service to be imposed will determine to a large extent the percentage to be allowed for depreciation and maintenance. Ordinarily 20 per cent. of the first cost is a fair

allowance for covering the fixed charges and will be used here.

A Common Unit Basis for Losses

In order to compare these several losses and charges, it is first necessary to bring them to a common unit basis. For this purpose the B.t.u. loss per pound of steam transmitted is perhaps the most convenient unit. The primary effect of drop in pressure is to increase the steam consumption in the engine cylinder and to decrease economy at this point. The percentage of this effect per pound drop will depend more or less upon conditions, such as: initial pressure, exhaust pressure, B.t.u. loss in the rejected steam, and the relative efficiency of the cylinder throughout the different ranges of pressures and temperatures. The effect of a one-pound drop is less, therefore, with high than with low initial pressures, and greater for noncondensing than for condensing conditions, other things being equal. Since increasing the steam consumption of an engine multiplies the total B.t.u. loss in the rejected steam, the effect of drop increases with the losses between the cylinder and the boiler. The drop not only causes a loss equal to the difference in the number of B.t.u. contained in the steam at the different pressures, but is responsible also for all heat losses due to the increased consumption. The temperature entropy is the best method of arriving at the effect of drop upon steam consumption. For the purposes of this paper the thermal efficiency of the cylinder is taken as uniform. This latter assumption, while not true for wide ranges, is believed to be amply correct throughout ranges corresponding to the ordinary drop of pressure in steam pipes. After determinating the increase in the steam consumption the next step is to reduce this to its equivalent in B.t.u. loss per pound of steam supplied or transmitted. This is done by subtracting the heat units returned to the boiler from the total heat of the steam and multiplying by the increase per pound in the consumption, as determined from the temperature entropy equivalent of drop in pressure.

The B.t.u. loss by radiation per pound of steam transmitted is equal to the total loss by radiation divided by the number of pounds transmitted. With formulas Nos. 1 and 2 and the above data as a basis, Fig. 1 has been made up, covering the losses in 1000 feet of different sizes of pipe for different velocities and an initial pressure of 100 pounds absolute. This curve sheet is based on noncondensing conditions. Fig. 2 shows corresponding combined losses for noncondensing conditions. The line joining the lowest points of these combined loss curves, is the line of most economical velocities as far as frictional and radiation losses are concerned, only. The other curved lines in Fig. 2, running more or less parallel to and on the right of the line just mentioned, are the lines of most economical velocities, taking into account the fixed charges on the piping at different first costs per linear foot. In making up these latter curves, the fixed charge is figured at 20 per cent. per year on the first cost and reduced to its equivalent in B.t.u. loss per pound of steam transmitted. In this transformation coal is figured at $3 per ton, and as delivering 10,000 B.t.u. per pound to the steam. Or in other words, fixed charges are figured as being equivalent to

$$U'' = [0.2\left(\frac{Z\,L}{3}\right) 2000 \times 1000] \div [w' \times 60 \times 24 \times 365] = Z\,\frac{2.536}{w'},$$

where Z equals cost of pipe in dollars per linear foot. The total charges against the piping may be taken, therefore, as being equivalent to

$$K\left[0.000131\left(1+\frac{3.6}{d'}\right)\left(\frac{w'^2\,L'}{D\,d'^5}\right)\right] + \left[\frac{0.09\,d''\,L\,(T_8 - T_0)}{w'}\right] + \left[Z\,\frac{2.536\,L}{w'}\right]$$

in B.t.u. per pound of steam transmitted. In this formula K equals the equivalent of one pound drop in pressure in B.t.u. per pound of steam transmitted.

By substituting proper values corresponding to different diameters, pressures and prices per foot of piping, and solving for a minimum, values of w' are gotten corresponding to the most economical velocities as shown by the curves. For other unit prices of coal and different boiler efficiencies, corresponding alterations should be made in the formula and curves drawn to suit. The values selected are intended to represent average conditions and will no doubt prove accurate enough for ordinary purposes. Attention is drawn in connection with all curves to the fact that L' is taken as being equal to L, or in other words, no allowance is made for friction added by bends and valves. In cases involving a number of sharp bends and globes, special solutions and extra curves must be resorted to for accurate results.

In cases where the plant is intended to operate for portions only of the 24 hours per day, or of the 365 days per year, the first cost of piping may be multiplied by 8760 (the number of hours in a year) and divided by the number of hours of actual operation per year, and this result be used instead of the actual cost of the piping. A similar correction may be made when a fixed charge other than 20 per cent. of first cost is to be used, by multiplying the first cost by the number of desired per cent. and dividing by 20, using the result in place of the actual first cost. Or both of the above corrections may be made when necessary, one after the other.

Attention is also invited in connection with all the curves, to the fact that they are figured for a continuous unity load factor. For variable loads the economical velocities given should be multiplied by a factor to be determined from the load curve. Considerable judgment is required in selecting this factor accurately without going through a series of laborious calculations. If very accurate results are required, the several losses must be figured separately for each load; in which case the curves can be of little assistance. For ordinary purposes, however, a factor can no doubt be selected, which will prove accurate enough for practice. For load curves with but little fluctuation, this factor might be made equal to the maximum load divided by the average load. For load curves with greater variations, a factor may be used equal to the quotient gotten by dividing one-half the square root of the mean square load plus one-half the average load, into the maximum load. The curve sheets are without doubt self-explanatory as to their use.

For other than 100-pound initial pressures, the following factors are given by which the economical velocities shown for 100 pounds are to be multiplied to get economical velocities for the other pressures. Results gotten by using these factors are accurate within about 2 per cent., which is close enough for this work. A similar factor is given for converting the economical velocities shown for noncondensing conditions to corresponding values for condensing conditions. In both charts the steam pressure equals 100 pounds absolute and the B.t.u. loss per square foot of pipe per hour per degree difference in temperature equals 0.35. In Fig. 2 the factors referred to above are, for 150 pounds steam pressure, 1.37; for 200 pounds steam pressure, 1.66; for condensing conditions, 1.25.

Owing to the number and variable character of the factors entering into the problem of determining the economical velocities, it is practically impossible to construct a simple set of curves covering all cases. The curves shown, it is believed, will, with a little experience and judgment in their use, cover a number of cases in a practical way. The influences of the cost of piping upon economical velocities is shown by the curves. The wide difference in cost for the same size of pipe in different plants illustrates very plainly the value of close preliminary estimating on first costs before selecting velocities. In connection with the application of the curves to any system of high-pressure piping, each section, main or branch may be treated separately. Changes in velocity either from a higher to a lower velocity, or *vice versa*, are inadvisable and the figured velocities should be adjusted so as to be nearly uniform throughout any one system. Care should be exercised to have changes in velocity, if any, as gradual as possible.

Filing Current Engineering Literature

BY WILLIAM H. BRYAN*

Modern technical literature comes in many different shapes. The average engineer receives only a small proportion of the whole, and only a still smaller amount can he preserve. He will, of course, accumulate a library, but he cannot invest largely in that direction. Furthermore, practice must have become fairly well standardized before it reaches the text- or reference-book stage. He will subscribe for a few good journals, but he will find that their preservation and care is a constantly growing problem—one which in time he will have to master.

Much good is being done nowadays by the libraries, many of which preserve the leading engineering journals, and bind them in permanent form. This is a particularly useful field for the modern engineering society, excellent examples of which are now found all over the country. To many engineers, however, the libraries are not accessible, and even where they are within reach, there are many subjects concerning which the engineer desires to keep the records of the latest and best practice close at hand.

Another class of literature of decided value comes from manufacturers, many of whom maintain extensive engineering departments, whose work is supplemented by laboratories and other testing facilities in which much advanced work is done. The results of their researches are promptly presented to the profession in bulletins and catalogs. Many of these are of great value, and are preserved by engineers in various ways. Some manufacturers furnish binders for this purpose, together with frequently revised indexes. This is an excellent plan, except that the circulars of those manufacturers who build different lines are necessarily separated from any general classification of the same subjects.

The writer's first work in this direction was to purchase a large alphabetically paged scrapbook. He did not expect to collect much data, and the circulars, which were small and few in number, were simply placed between its leaves in alphabetical order, some of the smaller ones being pasted in place. This plan was soon outgrown. Next the old-style paper letter files with alphabetical pockets were employed. It was soon found that the accumulation of matter on certain subjects necessitated subdividing the alphabetical arrangement, giving separate divicions to such subjects as boilers, engines, furnaces, etc. This plan answered well for a while, but the divisions soon began to fill so fast that further reclassifications, and the use of additional filing cases became necessary. It soon developed that the ordinary paper case would stand but little crowding or handling. Similar cases of heavier paper, with canvas covers, were then selected and served for quite a while. In time these showed signs of wear, accumulating much dust and becoming unsightly.

Finding that this system was after all inadequate, an entire rearrangement was decided upon. The filing cases were abandoned and regular box letter files were adopted, about 100 being purchased to start with. The alphabetical indexes which came with them were discarded, and an independent personal index made up covering the entire range of subjects to be preserved. This index was primarily alphabetical, each subject being given a division number, with subheadings in which the Dewey decimal system was employed. In many cases an entire box was required for a single subject, and in some few cases several boxes. In general, however, several different subjects were placed in a single box separated either by thick pieces of cardboard, or better still, in heavy envelops slightly smaller than the box, each marked with subject and number. This system could be expanded almost indefinitely, and has proved reasonably substantial. As the circulars, etc., come in day by day those which seem worth preserving are placed in a convenient drawer. When this fills, say once or twice a month, it is carefully gone through, and on each pamphlet is marked, with red or blue pencil, the number of its division in the file. The entire mass is then given to an assistant to file away. A simple request for division so and so brings all the accumulated literature on that subject.

To keep such an index in proper shape it should be carefully gone through every year or two, for the purpose of weeding out duplicates and antiquated material. This is always a job of magnitude.

Even this system is proving to have its limitations, as the wooden filing boxes will not stand continuous handling nor overcrowding. The writer has recently considered a further change which would be to a system of vertical filing similar to modern letter filing. This would, of course, require a considerable investment in cases and draws, and would occupy much room.

The other, and even more difficult, problem, refers to that valuable portion of engineering literature which comes in the current engineering journals. No engineer can hope to preserve these volumes intact for very long, on account of the shelf room required. The writer began by preserving everything, with no special plan of indexing, relying upon his memory and the indexes which came with the journals, and on the excellent general indexes which were then becoming available. This, of course, soon proved unsatisfactory. The next plan was to mark all articles of special interest, and write out an index card giving title, location and date, these cards being filed alphabetically. This served fairly well until the accumulation of back numbers became a problem. In desperation the writer sent out to his residence two wagon loads of back journals, and the consternation with which these were there received can better be imagined than described. Here, in out of the way corners and attic shelves were constructed, not without protest from the powers that be. This simply deferred the day of reckoning, and offered no permanent remedy.

The writer was aware that the practice of many engineers was to clip interesting articles, destroying the rest of the journals. This did not, however, appeal to him, as it looked like ruthless destruction and waste. He felt that some day he might want the entire paper; also that the preservation of the clippings presented an equally difficult problem, as there would often be valuable articles on opposite sides of the same page. He decided, however, to look into this plan and was fortunate enough to have the privilege of investigating the systems used by two busy engineers, John W. Alvord, of Chicago, and Prof. D. W. Mead, of Madison. Their system, with some minor modifications suited to his special needs, has now been adopted by the writer.

The desired articles are marked as before, and the journal is then given to an assistant who takes out the binding, detaching the complete article and placing it in a folder in its proper division in a vertical filing case, of the type now commonly used for ordinary correspondence. The general arrangement is alphabetical. Each folder is limited to a single subject, but under each letter there are one or more folders for miscellaneous subjects. When a folder becomes full its contents are transferred and bound up permanently in an ordinary cloth and paper binder, whose outside dimensions are 8½x12½ inches. This size will take many sizes of pages directly, including POWER, while others like *Engineering News* require a single fold. Before being bound the articles are arranged according to date and such further subdivisions as seem desirable. A typewritten index is also prepared and bound with the other matter. This volume is then put away in an ordinary book case,

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where, with later accumulations, it may be said to fairly represent the "state of the art" on that particular subject.

When interesting articles appear on opposite sides of the same sheet, several plans may be followed. In many cases it will be found on reëxamination that the data on one of the pages are of questionable value, and may be discarded. If very valuable a second copy may be purchased. In other cases the article may only run over a short distance, in which case it may either be clipped, or copied on the typewriter. When none of these serve there remains the plan of cross indexing, the articles being left together and filed under the most important subject. The less important article is indexed on a separate sheet or card which is filed in the place where that article would ordinarily be looked for, the reference being to the article under which the two were filed together. This plan is working successfully in many offices. It will be found easy to maintain such a system when once started, but the writer's difficulty is in going through the accumulated volumes of journals for years back, and in detaching, filing and cross indexing the back articles.

Another interesting subject to which there has been recent editorial reference is the indexing of all existing literature on a particular subject. Many such bibliographies have recently been prepared, and are of immense value. Many Government reports, and many papers before engineering societies have been accompanied by similar indexes. It is to be hoped that compilations of this character will become more and more frequent.

A Checking Coal Trolley

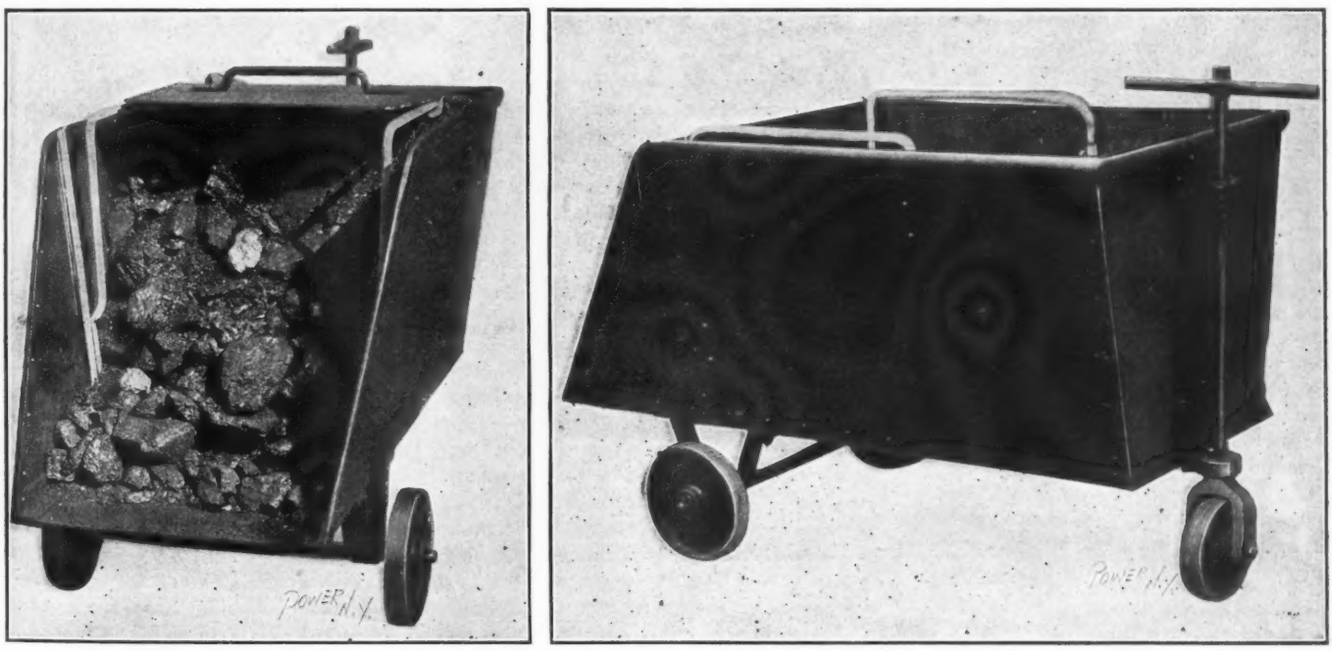
By C. A. Clarke

The chief engineer of the Brentford Union institutions near London has hit upon a novel method of keeping a check on coal consumption without weighing. The method is perhaps not accurate to within 1 per cent., but it enables a check to be kept on coal combustion at hospitals and other public institutions, so that at any time the stock of coal in hand can be known by difference. The apparatus is simply a trolley by which coal is conveyed from the coal pile to the boiler-house floor.

As the illustration shows, the front plate of the trolley is a slightly tapered plate which slides into place behind a pair of bars riveted to the trolley sides. This plate is attached by eyes to two round, bent bars, so that when not in place as a side of the trolley, it is resting on the top of the trolley. The trolley is proportioned to hold 500 to 900 pounds of coal according to size, and when shovel filled it becomes full with this weight of coal. If the coal is changed, a loaded trolley is weighed so as to find the actual weight, and this is used in all subsequent loadings up of that coal. Thus if the trolley shows 617 pounds, and ten of them are used in a given time, the total coal used will be 6170 pounds. Much trouble may be saved by the use of this trolley. It will be noticed that the bottom plate comes well forward. This serves as the shoveling floor and saves about a foot of lift as well as facilitating the use of the shovel.

The back wheel, or steering wheel, is seen to be carried on a swiveling vertical spindle with a T handle. This wheel being set transversely and the spindle pinned, the trolley is held to the ground and will not slide back under the push of the shovel when taking coal. The trolley can be stood at the most convenient part of the boiler-house floor, and its use obviates all need for coal on the floor. A trial run demonstrated that in a weighed mass of over 40 tons (2240) of coal, the trolley, filled regularly in the course of regular work, checked that weight to within 900 pounds.

While primarily intended for use in connection with coal-burning plants, the trolley may also be used in proportioning the rough materials employed in cement manufacture and in many other ways. But it was designed as an aid to the engineer in charge of public institutions and electric-light stations desiring a reasonably accurate check on fuel consumption, where the exact weight is not practicably to be obtained. And incidentally it has proved a very efficient means of keeping clean the floor of the boiler house and also of easing the fireman's labors in firing the coal.



A Convenient Form of Coal Trolley

Carefully studying the boiler-repair question, which resulted in placing a man in general charge of the maintenance of boilers and the issuing of permanent instructions concerning the exact way in which the boilers should be cleaned and washed, and seeing that they were inforced, almost did away with the ordering of stay-bolt iron on one railroad.

ELECTRICAL DEPARTMENT

Especially conducted to be of Interest and Service to men in charge of Electrical equipment.

Electric Elevators

By William Baxter, Jr.

As explained in the preceding article, an elevator motor does not at all times do work; sometimes it drives the elevator machine and thereby moves the car, but at other times it is driven by the descent of the elevator car. If the car is running up with little or no load, and is overbalanced, the excess of weight in the counterbalance will pull the car upward. On the other hand, if the car is coming down with a heavy load it will weigh more than the counterbalance and will pull the latter upward. In both these cases the motor must not only not do any work to drive the car, but must put forth an effort to hold the car back so that it may not attain a dangerous speed, and this effort must vary with the weight in the car, being very small if the difference between the weight of the car and the counterbalance is small and great if the difference between the two weights is great. It is a fortunate natural characteristic of an electric motor that it will work automatically in the way described, retarding the motion of the car in strict conformity with the requirements of the conditions at the time.

This is more easily explained with the aid of the simple diagram, Fig. 87. In this diagram *G* represents a generator that delivers current into the circuit *E E E* in which is included an elevator motor, the shunt-field winding being connected between the points *A* and *B* and the armature *M* between the points *C* and *D*. When the motor is running as a motor the currents will flow through the circuits as indicated by the arrows *a*,

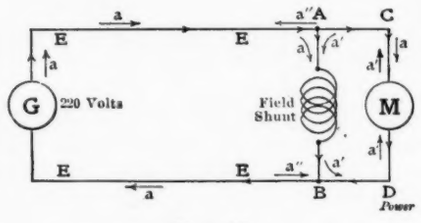


Fig. 87

but when the motor is driven by the weight of the elevator car or the counterbalance beyond its normal speed it acts as a generator and delivers current instead of receiving it; consequently, current in the armature circuit will flow in the direction of the arrows *a'* and *a''*. For example, suppose that the motor is a 10-horsepower machine and runs at 1000 revolutions per minute when developing its full power, and that the current passing through its armature at that time is 40 amperes. Also suppose that the resistance of the armature is ½ ohm. Then at full load the drop in the armature will be

$$40 \times \tfrac{1}{2} = 20 \text{ volts},$$

so that the counter e.m.f. will be 200 volts; this is at a speed of 1000 revolutions per minute. Now suppose that the motor be forced to run at 1050 revolutions per minute; the counter e.m.f. will then be 210 volts, leaving only 10 volts of the impressed e.m.f. to overcome the armature resistance of ½ ohm, and the armature current will therefore be 20 amperes. When the speed reaches 1100 revolutions per minute, no current will pass through the armature because the counter e.m.f. of the armature will be 220 volts, which will just balance the line voltage.

At this speed the motor will cease to act as a motor and simply be driven idly, because no current passes through its armature from the line. If the speed is still further increased, however, say up to 1150 revolutions, the machine will be acting as a generator, and will deliver current into the line instead of drawing current from it, the counter e.m.f. at that speed being 230 volts, or 10 volts higher than the line e.m.f. The strength of the current sent into the line will depend on the resistance of the generator circuit *E E*. To deliver current into the line in opposition to the generator *G* requires power to be applied to rotate the armature; hence, as soon as the motor reaches a speed at which it begins to act as a generator, it absorbs power from the elevator mechanism which is driving it and acts to hold the elevator back.

From the foregoing simple calculations it can be seen that if the car is coming down with a heavy load it will run at a faster speed than if going up, but the difference will not be very great, for with a slight increase in speed the current generated in the motor armature is greatly increased. Thus if at a speed of 1120 revolutions per minute the delivered current is only 2 amperes, at 1200 revolutions it will be 10 amperes and at 1300 it would be 20 amperes. As the friction of the elevator machine and all the other apparatus absorbs a considerable amount of power, it would be hardly possible for any load that may be carried to run the armature speed up as high as 1300 revolutions per minute.

In the foregoing example, when the armature reaches 1100 revolutions, the counter e.m.f. just balances the line voltage. This is what is called the "critical" speed; below it the machine acts as a motor, and above it, as a generator.

The explanation here given of the action of a motor when running at different speeds, while strictly correct, is not exactly what would actually occur in practice, because, in order to make the explanation as simple as possible, I have assumed that the electromotive force between the points *A B* and the points *C D* in Fig. 87 remains constant at 220 volts. This is not possible in practice because the circuit wires *E E* must have some resistance, and as a result the voltage between *A* and *B* will be less than at the terminals of the generator *G*, and will vary with the strength of the current passing to the motor, being reduced as the current increased and increased as the current reduces. This, however, does not affect the principle of operation in the slightest; it merely changes the figures to a small extent. The strength of the current flowing through the motor armature also acts to change the figures in the calculations slightly, as the armature current reacts on the magnetism developed by the shunt-field winding.

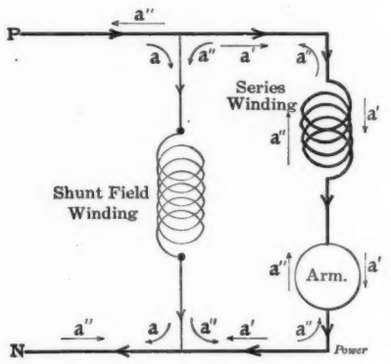


Fig. 88

In Fig. 87 it will be noticed that whether the motor acts as a motor or as a generator, the current through the shunt field winding is in the same direction always; as the critical speed point is passed the field-exciting current is simply shifted from the generator to the motor armature, but its direction of flow is not changed, and neither is its strength, assuming the potential between the point *A* and *B* to be constant. If the motor is not of the simple shunt-wound type but is compound wound,

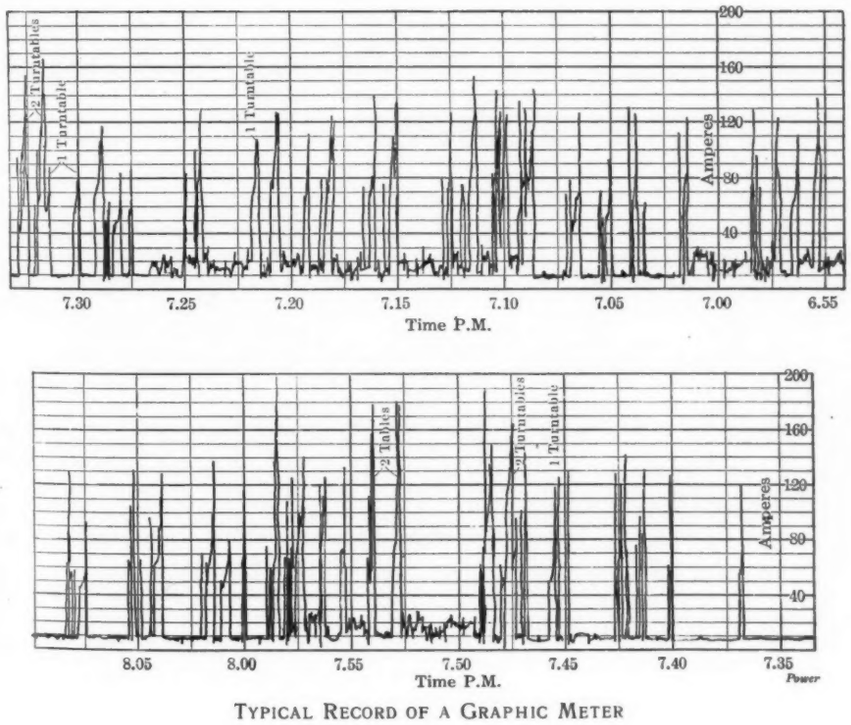
then when the speed passes above the critical point the strength of the motor field magnet is changed. This action can be better explained by the aid of the diagram, Fig. 88, in which there is a series field winding in addition to the shunt winding of Fig. 87.

If an elevator is operated by a motor of this type, when the motor is lifting the load, the current will flow through the shunt field winding in the direction of arrows *a*, and through the series field winding and the armature in the direction of arrows *a'*. When the currents flow in this direction, the magnetism developed by the series field coils will act in the same direction as that of the shunt field coils; that is, it will act to strengthen the field and thus to increase the pull of the motor armature.

If, however, the load is sufficient to drive the motor as a generator, as soon as the armature runs above the critical speed it will begin to deliver current and this will flow in the direction of the arrows *a"*; while this will be correct for the shunt field coils it will be in the opposite direction to what it should be for the series winding, and that will therefore act in cpposition to the shunt and instead of increasing the strength of the motor field, it will reduce it. The effect of this will be to reduce the power required to drive the armature, hence it will speed up. If the series winding is small its effect may be slight, and the actual result will be a slight increase in the speed of the motor; but if it is a "heavy" winding it will develop a strong magnetizing force and may be able to neutralize the shunt field winding to such an extent as to reduce the motor field strength enough to cause the armature to run up to a dangerous speed. If the controller is made so as to cut out the series field coils as soon as the armature runs up to full speed, leaving the motor running as a straight shunt-wound machine, there is no danger of its running away if it is driven above the critical speed by the load. In some cases, however, compound-wound motors are provided with controllers arranged so that the operator in the car can cut the series field winding in or out of circuit, this construction being used so that when a very heavy load is raised the series winding may be cut in and the working current reduced. The arrangement, considered from the point of safety alone, is not desirable, because the operator may forget to cut out the series winding when the load is driving the elevator, and there may be a serious runaway.

How a Recording Meter Analysis of a Substation Load Disclosed the Possibility of Reducing the Equipment.

An example of the value of the recording meter for analyzing power loads was recently shown in a substation which supplies power to the terminal yards of a large railroad system. In this instance, as a result of the application of the meter, it was found possible to reduce the capacity of the machine operating by more than half, thereby diminishing operating expenses and improving the efficiency and load factor of the remaining generating equipment.



TYPICAL RECORD OF A GRAPHIC METER

The substation referred to contains one 37½-kilowatt and two 25-kilowatt motor-generator sets. These supply direct current at 250 volts to three turntables and one small crane. Each of the turn tables is driven by a 22-horsepower series-wound motor with rheostat control, and is capable of turning a locomotive end for end in one minute. The crane is of about five tons capacity and subject to very intermittent service, so that its operation has little effect on the total station load. The turn tables are held ready for service at all times. Rush-hour periods occur in the morning and evening, and at these times the tables are usually very busy. It is seldom that two turn-tables are started at once, although two or three may be in operation at the same time.

Before the study of the actual load conditions had been made it was customary to operate all three motor-generator sets during the rush hours. At these times the violent oscillation of the needles of indicating meters on the generating panels, striking against the stops, seemed to indicate that more generating capacity was needed. In order to determine this latter question definitely, a Westinghouse graphic recording meter was inserted in the main feeder. The tests covered a week's careful study, during which time the load on the station was continuously recorded. That section of the curve reproduced herewith was secured during one of the rush periods. To obtain a clear record, a paper speed of 24 inches per hour was used. The record shows that the average peak load produced during the starting of a turntable is 120 amperes. This drops to a value of from 50 to 70 amperes during operation, after the table has been accelerated. The maximum peak noted was about 180 amperes, when two turntables were started simultaneously.

As the full-load current of the 37½-kilowatt motor-generator set alone is 150 amperes, it is clear that the existing station capacity is ample to handle the present service besides a large future increase. Since the tests it has been found sufficient to operate only the one largest unit, and the former practice of running all three sets has accordingly been discontinued. The result has been improved operating economy, efficiency and load factor.

The graphic indicating meter is equally useful, of course, in showing up overloaded apparatus, and often performs valuable service in indicating unsuspected load conditions which give rise to excessive heating and impaired regulation and efficiency, the cause of which cannot otherwise be traced.

Experience has proved that in almost every power operation there may be considerable unknown and unnecessary losses, which may be promptly localized

by analyzing the graphic meter curve, and remedied with resulting increased production or decreased operating expense.

Using Standard Transformers to Run a Two-phase Motor from a Three-phase Circuit

By Byron T. Mottinger.

In a pumping and lighting station where a 1100-volt, two-phase system was replaced by power purchased from a large hydroelectric power company supplying three-phase 2300-volt current at the same frequency, it became necessary to operate a two-phase 440-volt induction motor of 110 horsepower from the three-phase 2300-volt circuit as a temporary means of supplying the city with water for a period of several months. It was desirable to use standard transformers for this purpose because the city had them on hand.

The motor formerly received its power from the 1100-volt circuit through two 50-kilowatt transformers having a ratio of 1100 or 2200 to 220 or 440 volts. These two transformers were used in connection with a 7½-kilowatt transformer having a ratio of 1150 or 2300 to 115 or 230 volts, in connecting the motor to the three-phase power circuit. The 57½-volt taps were brought out of this transformer and connected for 57½ volts on the secondary side. Connected in this manner the 7½-kilowatt transformer had a current capacity of 130 amperes, while the current capacity of the 50-kilowatt transformers was but 113 amperes on the secondary sides.

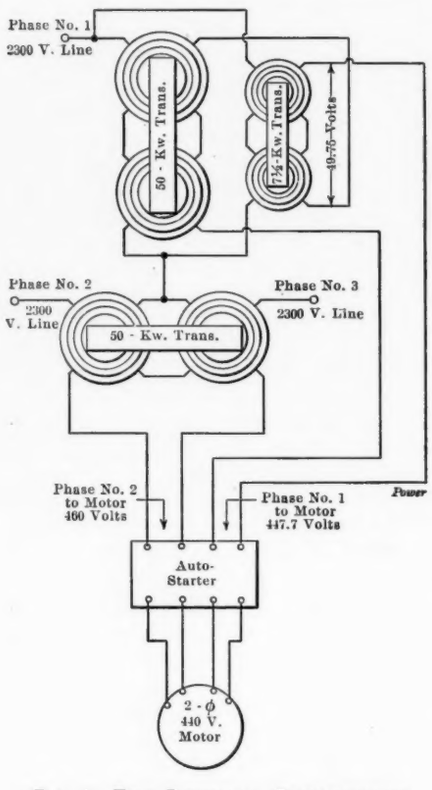


Fig. 1. The Physical Connections

The three transformers were connected up according to the accompanying diagrams which show a slight modification of the Scott connection, in that the 7½-kilowatt transformer is used as a booster on the 86½ per cent. leg. The 50-kilowatt and the 7½-kilowatt units in this leg have impressed upon their primaries but 86½ per cent. of the line voltage between the three phases, or 1990 volts. The 50-kilowatt unit, having a 5 to 1 ratio, produces 398 volts at its secondary, and the 7½-kilowatt unit, having a 40 to 1 ratio, produces 49.75 volts at its secondary. By connecting these two secondary circuits in series so that their e.m.f's are cumulative, 447.75 volts are obtained for phase No. 1 at the motor. The 50-kilowatt transformer connected from phase No. 2 to phase No. 3 on the primary side, also having a ratio of 5 to 1, produces one-fifth of 2300 volts, or 460 volts at its secondary, and this is the voltage of phase No. 2 at the motor.

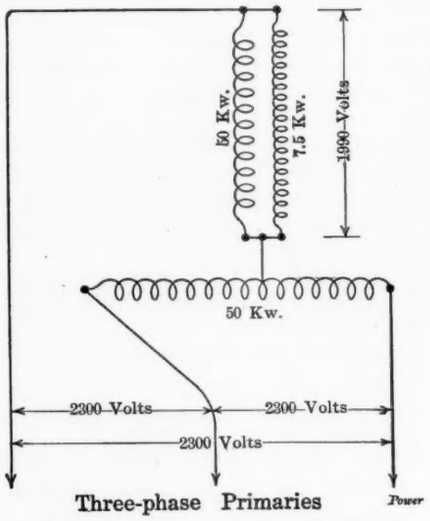


Fig. 2. Diagram of Primary Connections

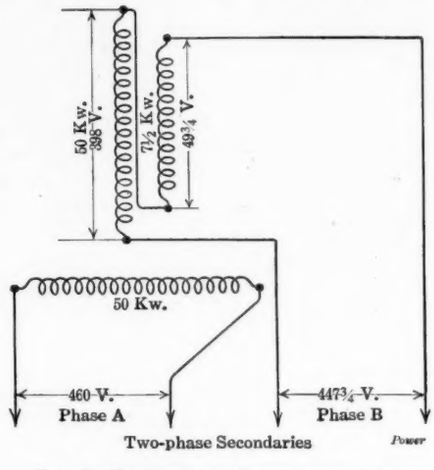


Fig. 3. Diagram of Secondary Connections

With this arrangement of transformers phase No. 1 of the motor received an excess of 1.76 per cent. in applied voltage, while phase No. 2 of the motor received an excess of 4.55 per cent. in applied voltage. Any well designed induction motor will operate satisfactorily with a voltage 5 per cent. above or below the rated voltage, unless the conditions imposed upon it are very unfavorable. Induction motors often cause trouble when the phases are interconnected, and at the same time the voltage supplied to the phases differs too widely. Under these conditions one phase is apt to take power out of the line and supply it to the other phase. The particular motor referred to above was not interconnected.

Turbo-generator Units through Fire Experience

In an extraordinarily severe test from intense heat exposure occurring during a recent fire at the Trinidad plant of the Southern Colorado Power and Railway Company, two Westinghouse turbines came through in remarkably good condition, while two simple reciprocating engines and some electrical equipment were damaged beyond repair. Some idea of the intensity of the heat can be had from Figs. 1 and 2, taken during and after the fire. Although the power house had rough stone walls, the roof and floor were of wooden structure, with light steel trusses for the roof supports, and old T-rails for the floors. These pine floors were oil-soaked, causing rapid spreading of the fire and adding greatly to the heat generated. The fire originated in the failure of some second-hand electrical equipments under heavy load, and the burnout ignited the inflammable material surrounding the apparatus. In three minutes after it started, it was impossible to get inside the engine room.

Just at the time the fire was observed, the load was being transferred from the 500-kilowatt to the 1000-kilowatt unit, and the automatic safety stops were tripped immediately after the floor took fire. Very likely these machines were spinning during the greater part of the fire, but no effect of rubbing was reported, due to the cylinder warping from the unequal heat exposure.

As to be expected, some exterior parts of both machines were damaged, to the following extent: Cylinder lagging was badly warped, and the governor valve gearing, valve piston rings and all springs on both machines were ruined beyond repair. The relay plungers were fused to the bushing, and the brass railings on the top platforms were partly melted.

Although the generator frames were discolored from the heat, the loss sus-

tained was, indeed, very small. The brush holders were practically destroyed, and the insulation burned off one of the leads on the 1000-kilowatt unit, which is the extent the generators suffered.

The short time in which the two turbines were repaired and again placed in service speaks for itself—the 500-kilowatt in ten days and the 1000-kilowatt in twelve days after the fire. This includes ordering new parts from East Pittsburg, time consumed in transit (about three days) and fitting up the machines, besides opening up the turbine for inspection—for which temporary rigging was provided. The 500-kilowatt unit had been in operation 18 months, night and day, without any repair cost. Repair parts to the extent of $11 were carried in stock and lost in the fire.

In all, the actual cost of repairing both units was about $2000, including painting, or approximately 5 per cent. of the cost. A Westinghouse-Leblanc condenser, connected to the 1000-kilowatt unit, was not affected, except for damage to the gaskets on the small piping and the pump motor. A surface condenser, attached to the 500-kilowatt machine, had the shell cracked at the middle, extending practically around the entire periphery.

FIG. 1. EXTERIOR VIEW OF PLANT TAKEN DURING FIRE

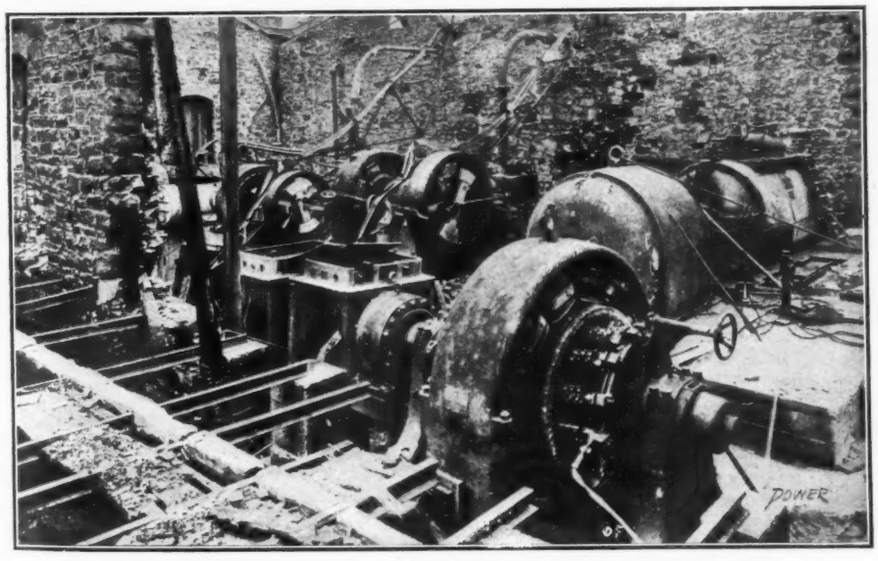


FIG. 2. GENERATING UNITS AND TRANSFORMERS AFTER THE FIRE

Edison Storage Battery Perfected?

About nine years ago it was announced that Thomas A. Edison had invented a new type of storage battery of very light weight and great durability, and three years later the battery was put on the market—and almost immediately withdrawn, because it did not come up to the inventor's expectations. After six years of experimenting, modifying and testing, the battery, it is announced, has finally been developed to a satisfactory point, and is now being offered in the market again. The general fundamental principle of using nickel oxide as the positive active material, iron oxide on the negative plates and potassium hydrate as the electrolyte has been retained; the improvements are entirely in mechanical details. The new cell is said to be much more durable than the original form and to have greater capacity. The smaller sizes are said to give 14 watt-hours per pound and the larger ones 16; the efficiency ranges from 57 to 65 per cent., on the watt-hour basis.

An experimental street car equipped with the new battery was given a short public trial run on January 20, between the Edison factory in Orange and the carbarn of the Public Service Corporation, about a mile distant, using the regular car track. The car behaved perfectly—there was no reason why it shouldn't—and the officials of the manufacturing company seemed highly pleased. Of course the trial was too brief to have any engineering significance; it is an old story that a street car can be propelled by power from a storage battery.

An Early Marine Engine

The following from an old *New York American*, published in the *Scientific American* over the name of Walter C. Bilelur, may be of interest, especially at this time of looking up ancient types of steamships:

"In the year 1819, while experimenting for the improvement of the steam engine, my attention was arrested by the great loss of heat under the circumstances in which steam is generally produced, and the idea of my present generator suggested itself to my mind at that time; . . . and in March, 1825, made the first experiment in R. L. Cawdrey's carriage shop, Ithaca, N. Y.

"I used a blacksmith's bellows to supply the fire with air, and concluded that about eight times as much steam was generated as air forced into the fire.

"The engine (which was installed in a Liverpool packet) is called a 'double steam engine,' having two steam cylinders of 35 inches diameter, 6 feet stroke; two blowing cylinders of just half the capacity; which are worked by the engine, and the air is conducted into a boiler whose outer cylindrical case is 4 feet in diameter and 12 feet high; the furnace, or inner case, is 3½ feet in diameter and 9 feet high. The fuel is introduced into it down the chimney, and it is so constructed that not one particle of heat can escape, but must absolutely pass into the water, together with all the gases generated by combustion, and become as strong an agent as the steam itself, passing through the steam cylinders with it."

The inventor, P. Bennet, of Ithaca, seems to have had a great deal of trouble with tar in his cylinder, as we would expect, but claimed to have overcome this difficulty.

GAS·POWER·DEPARTMENT

Everything worth while in the Gas Engine and Producer Industry will be treated here for the use of practical men

Test Run of a Producer and Engine Plant

By William O. Webber

At the Soldiers' Home, in Chelsea, Mass., there is an interesting little gas engine and producer plant, which was given a 30-day acceptance run recently. Fig. 1 is a layout plan of the plant. There are two Warren suction producers, each designed to burn normally 100 pounds of coal per hour, with a normal capacity of 8000 cubic feet of gas per hour; they are each 60 inches outside diameter and 36 inches inside diameter by 9 feet 3 inches high.

The construction of the producers is well shown by Fig. 2. The generator is equipped with a conical grate under the center of which is a distributing tuyere for the delivery of air and steam to the fire. A separate vaporizer is used which also serves to preheat the air supplied to the fire. The vaporizer shell is 22 inches in diameter and 9 feet high. The wet scrubber and dry purifier are built in one structure, with the latter on top. The wet-scrubber part is 12 feet high and the dry

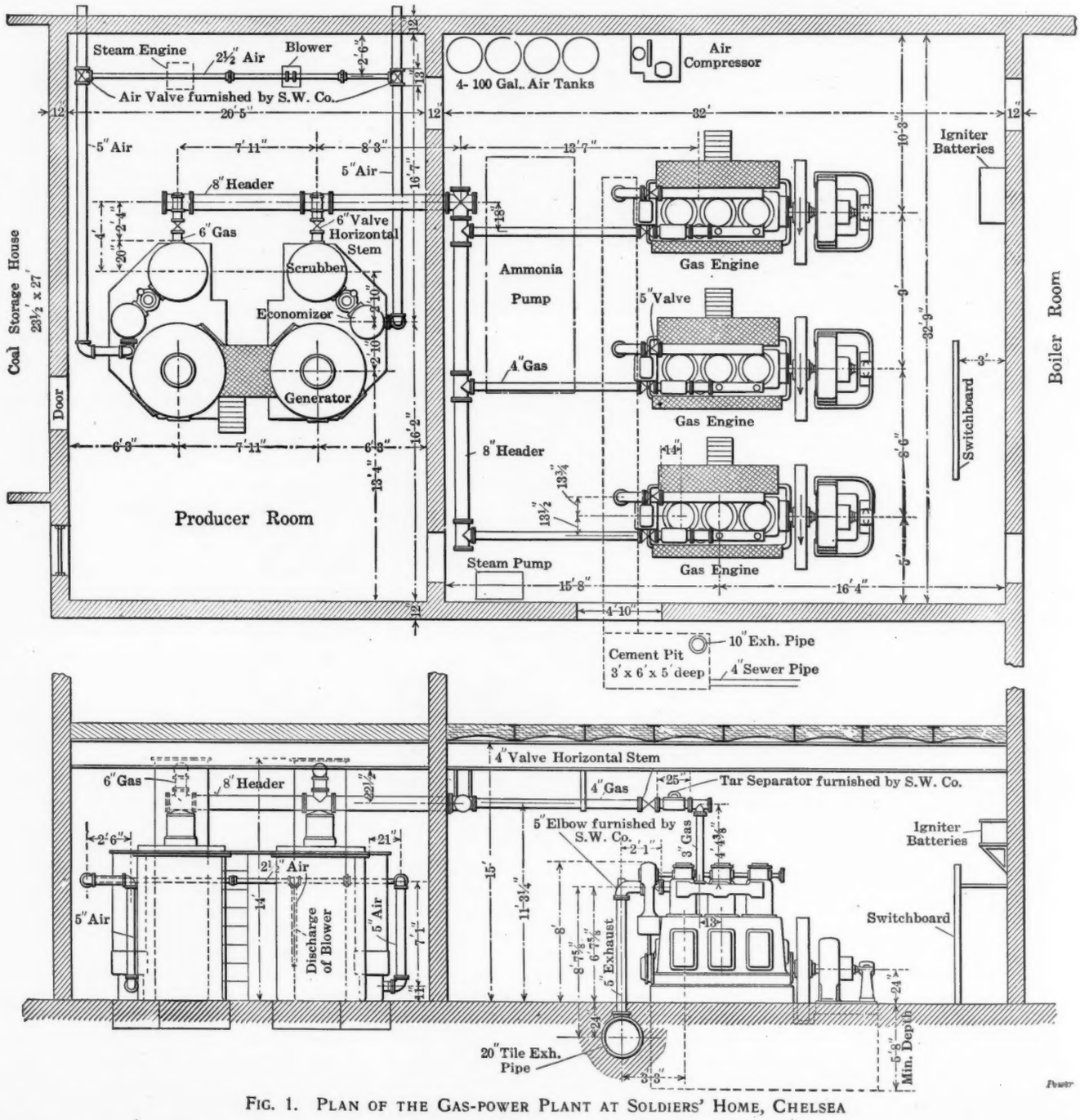


FIG. 1. PLAN OF THE GAS-POWER PLANT AT SOLDIERS' HOME, CHELSEA

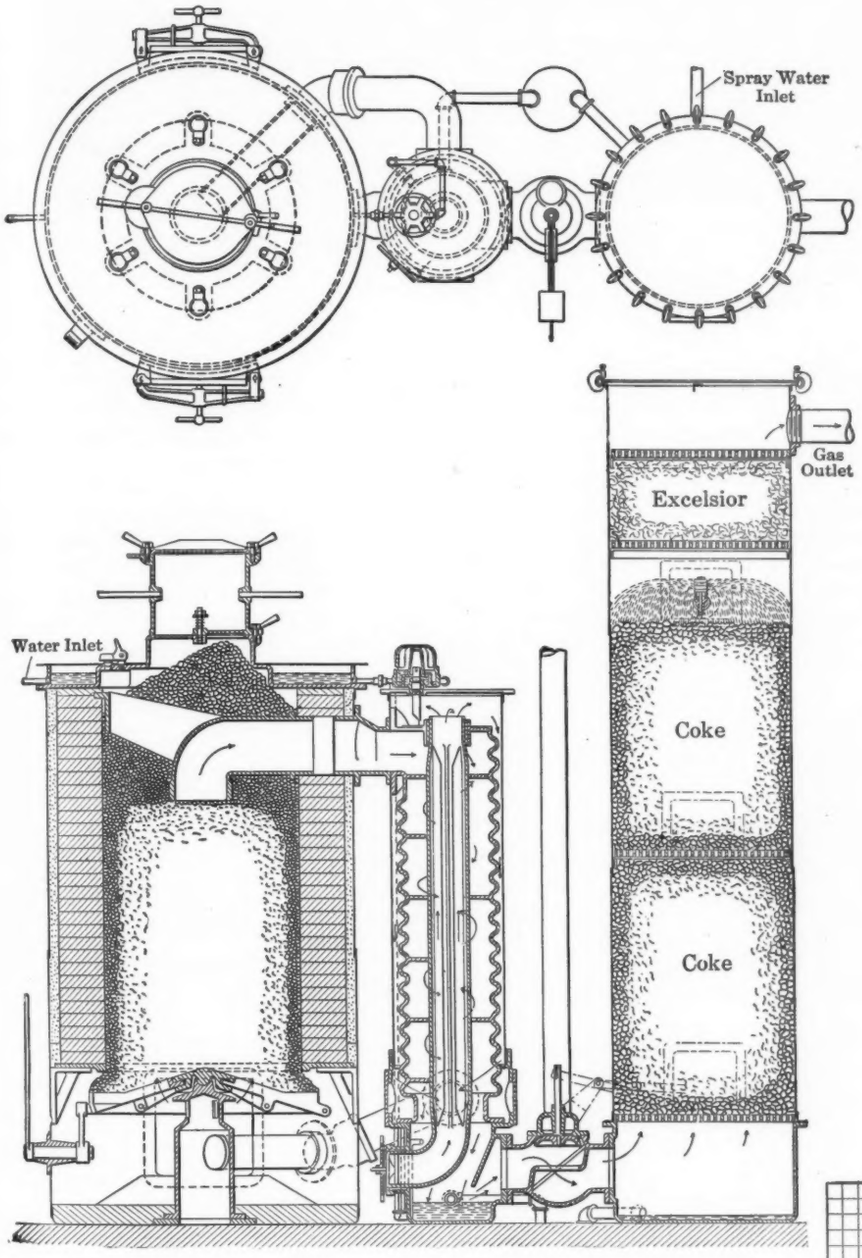


FIG. 2. PLAN AND VERTICAL SECTION OF WARREN PRODUCER

purifier 2 feet high; the diameter is 36 inches throughout.

The plant contains three Warren three-cylinder engines rated at 65 horsepower each, with cylinders 10 inches bore and 13 inches stroke; the normal speed is 320 revolutions per minute. Fig. 4 illustrates the construction of the engine as to one cylinder and the corresponding parts. The cam shaft runs along the tops of the cylinders and the cams open the respective valves through short rocker arms.

GENERAL RESULTS OF RUN.

	Half Load.	¾ Load.	20% Overload 1 Engine.
Number of running hours	582	48	6
Average load, kilowatts	22.03	35.7	61.66
Average brake horsepower	34.+	54.95	95
Load in percentage of engine rating	56.8	89	120
Pounds of coal gasified, total	35,010	3,955	637.5
Pounds of coal gasified, per hour	60.1	82.4	106.5
Ashes removed, pounds	9,173	1,067	160
Ratio of ashes to coal, per cent	26.9	26.9	26
Pounds of coal per kilowatt-hour	2.74	2.3	1.725
Pounds of coal per brake horsepower-hour	1.77	1.50	1.125
Pounds fuel per kilowatt-hour, guaranteed	2.25	1.75	
Pounds fuel per kilowatt-hour, actual	2.015	1.69	1.29
Pounds fuel per brake horsepower-hour	1.307	1.12	0.835
Average heat value of coal	12,047	12,047	12,047
B.t.u. per kilowatt-hour	30,400	27,600	20,810
B.t.u. per brake horsepower-hour	20,000	18,090	13,600
B.t.u. per horsepower-hour from producer	15,000	13,550	10,200
Thermal efficiency, brake	12.5%	14.05%	18.65%
Thermal efficiency, electrical	11.2	12.35	16.5

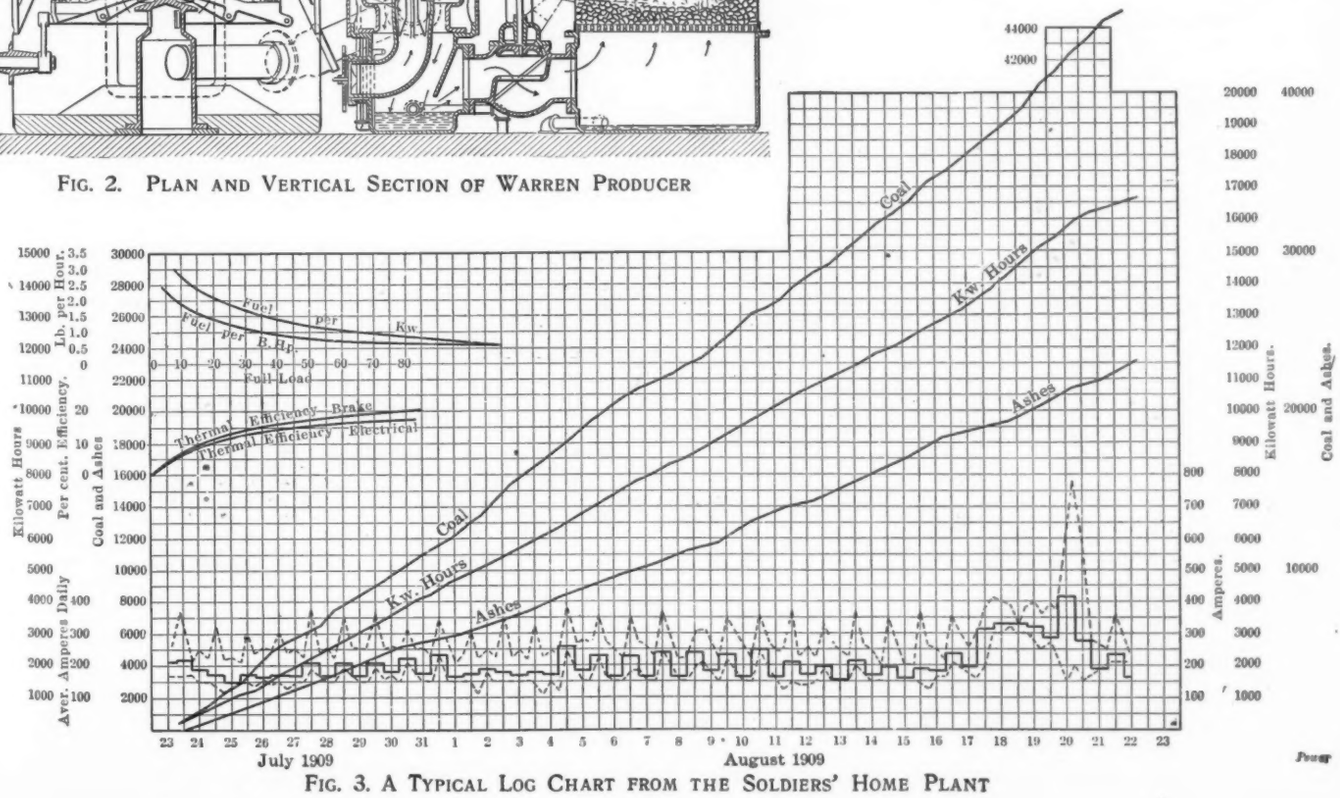


FIG. 3. A TYPICAL LOG CHART FROM THE SOLDIERS' HOME PLANT

The mixing valve and throttle are shown to the right of the cylinder head. The governor is of the vertical balanced-spring type, inclosed in an oil-tight case, and controls the supply of air and gas in proportion to the load. The igniters are of the "make and break" type, mechanically operated by eccentrics located on the cam shaft.

For starting the engines there are four compressed-air tanks with a total capacity of 16 cubic feet and a water-jacketed motor-driven air compressor; one cylinder of each engine is equipped with an air starting valve.

These engines are directly connected to three 40-kilowatt 125-volt direct-current compound-wound generators of Westinghouse make.

This plant is designed to drive four 18-inch, one 24-inch, one 54-inch and one 140-inch ventilating fans in the hospital building; three electric elevators; a laundry equipment of four double washers, one single washer, two 24-inch centrifugal driers, one 72-inch and one 60-inch mangle; one ice machine; one dish-washing machine; the motor air compressor; a 1½-inch centrifugal pump which forces the circulating water from the cylinder jackets into a cooling tower; another similar pump, pumping the water from the scrubbers and exhaust over into the sewer. Besides these motors, current is supplied to 1200 incandescent lamps. A belt-driven blower, driven by a 2-horsepower vertical engine, is provided for starting the producers.

The total work being done at this plant is estimated at 534,400 horsepower-hours per annum, distributed practically as shown by the diagram, Fig. 3. The plant is so designed that one producer and one engine will carry the day load, the second producer and engine being thrown into service at about 5 o'clock each afternoon, and the other producer cut out about 10 o'clock each night. During the summer months, one engine easily carries the maximum lighting load. In the winter both engines are used between 6 and 10 o'clock p.m., leaving one engine as a spare at all times.

A 30-day run on this plant, after it had been installed for two or three months gave the results shown in the table on page 271.

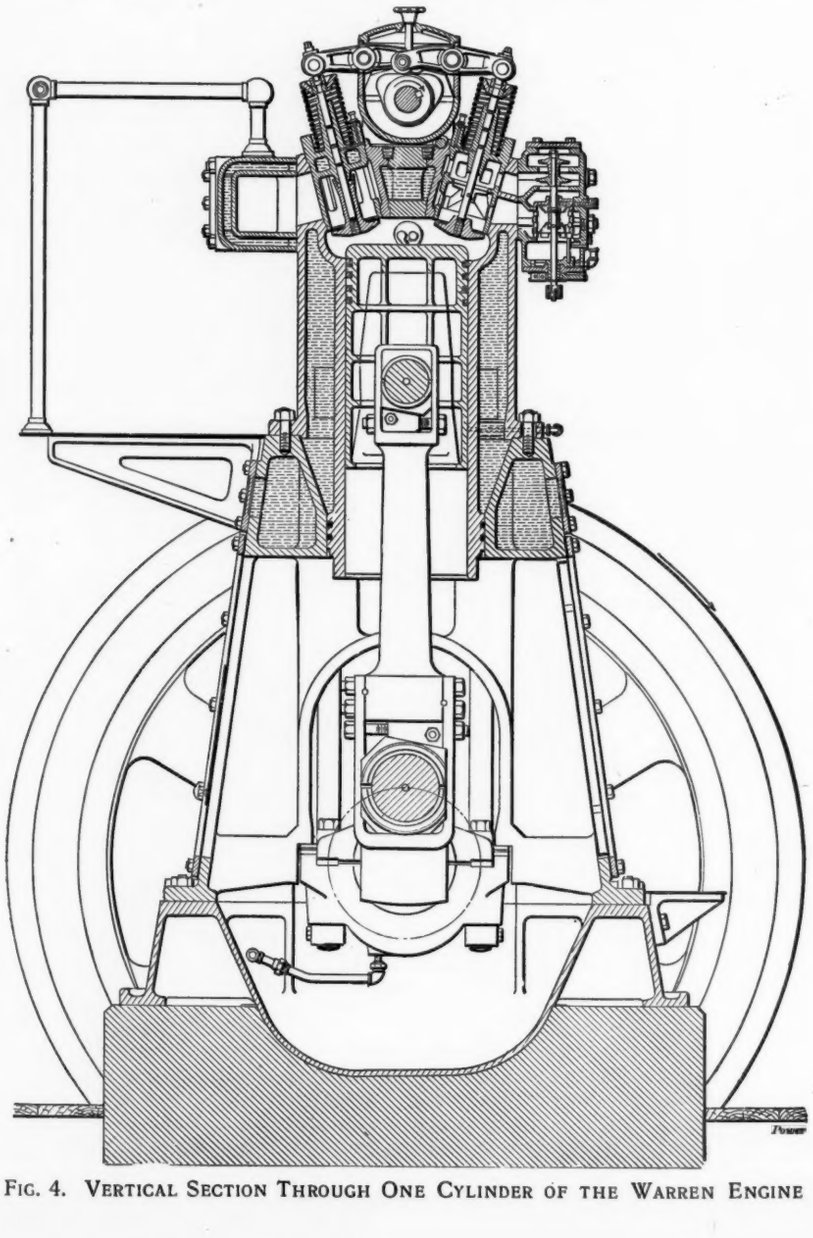


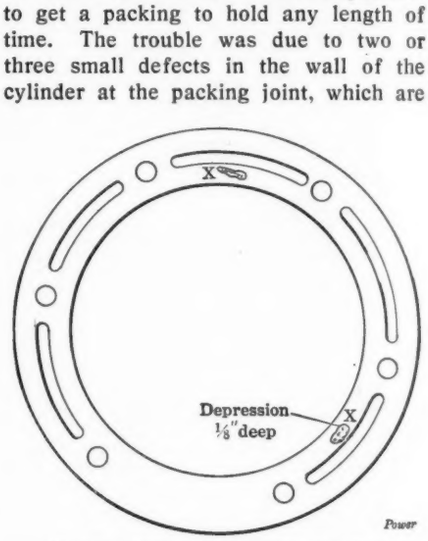
FIG. 4. VERTICAL SECTION THROUGH ONE CYLINDER OF THE WARREN ENGINE

Packing a Cylinder Head Having Casting Flaws

BY JAMES H. BEATTIE

One of the most troublesome features of gasolene-engine operation is the necessity of packing the cylinder head at frequent intervals.

One case I have had a great deal of trouble with is a vertical gasolene engine of well known make. It was impossible to get a packing to hold any length of time. The trouble was due to two or three small defects in the wall of the cylinder at the packing joint, which are



UPPER END OF CYLINDER BARREL

indicated at *X, X* in the accompanying sketch. In order to remove the cylinder head it was necessary to disconnect the fuel pipe, water pipes, exhaust pipe, exhaust-valve rod—in fact, to practically dismantle the engine; consequently, the repacking of this cylinder head meant a good half day's work. Why such a casting should have been allowed to leave the factory is a mystery. After trying almost everything, including gaskets soaked in linseed oil, gaskets coated with graphite, copper-asbestos gaskets, thin gaskets, thick gaskets and gaskets of marvelous shapes, the trouble was conquered by cutting an ordinary asbestos gasket and coating it on both sides with iron cement mixed with kerosene until it was like putty, then with water until a paste was formed. The cylinder head was quickly drawn down by the stud bolts, the engine started, and when warm the nuts were tightened gradually by going over them three or four times. The engine was then allowed to stand for a day or two. This gasket has been in three months and has not shown the least signs of giving way.

From READERS *with* SOMETHING *to* SAY

Practical information from men on the job—A letter good enough to print is good enough to pay for.

Cleaning Boilers

There is a wrong and right method of cleaning and keeping a boiler clean. Some engineers use the wrong way because they are in too much of a hurry. For instance, as soon as the pressure is down to 10 or 20 pounds the water is blown out, and the lower front manhole plate taken out and boiler washed from this point until the water comes out clean at the blowoff pipe. Then the manhole plate is replaced and the boiler filled with water to the proper level. The top manhole plate is perhaps taken out only when the boiler inspector makes an internal inspection. No one can thoroughly clean a boiler in this way, and it should not be employed.

When ready to cool a boiler it should be allowed to set as long as possible before blowing out. If the time is short the steam should be blown out and if the feed water is fed through the front head, the valve in the feed line should be opened a little and slowly feed cold water to the boiler. At the same time the blowoff valve is opened enough to keep the water at the same level.

Where the feed water enters the boiler through the blowoff pipe, the valve in the feed line should be opened to bring the water level in the gage glass to a certain point, then close the feed valve and lower the water again by opening the blowoff valve, and repeat until the boiler is cooled off sufficiently.

Another good plan to cool off a boiler, and eliminate cold water, where there are two or more boilers, and the boiler is to be washed out on a Sunday, is to keep one boiler under steam, and, if there is an open, or a closed heater in which the water is on the outside of the tubes, fill the heater with water on Saturday night before shutting down the engine and pump this hot water into the boiler that is to be washed. If the boiler is not cooled off enough after the heater is empty, cold water will have to be used. The reason an open or closed heater is mentioned with the water in contact with tubes on the outside is because these types of heater hold a large amount of water.

After cleaning the grates and ashpit the fire and tube doors should be closed and the damper in the smokestack opened wide, in order to create a draft through the ashpit, up through the grates and through the tubes. This air will cool the hot surface of the brick walls and boiler. Next the top manhole plate is taken out and the valve in the feed line closed, the blowoff valve opened wide and the boiler washed from the top of the tubes with a hose and as strong a water pressure as possible. This prevents any possibility of the soft mud baking on the tubes and shell.

After the boiler is empty the lower manhole plate should be taken out, as by this time the boiler will be cool enough to enter. Next, the boiler is washed from the lower manhole until the water comes out clean at the blowoff pipe. Then enter the boiler through the lower manhole, and remove all loose scale from the bottom of the shell, when the boiler is given another good washing from the lower manhole.

H. JAHNKE.

Milwaukee, Wis.

Increasing the Draft

I recently took charge of two horizontal tubular boilers which are connected to a smoke breeching which leads to a brick stack 80 feet high. This stack is built about 20 feet above the roof of the building but buildings have been built on both sides of the stack to about the same hight, hindering its draft to a great extent depending upon the direction of the wind. There were times when draft was rather poor and if our peak load happened then we were handicapped in keeping the steam up with one boiler. Of the two boilers we only ran one, so I began to think of an experiment which I thought would help matters. The boilers were set side by side with a wall 16 inches thick between. I cut two holes about 18 inches square in this wall below the grates. These holes put the ashpits of both boilers in communication with one another. When our draft happened to be rather poor we would open doors on the ashpit of the shutdown boiler and in doing that the air would go in ashpit, thence through these holes into the ashpit of the boiler that was in operation, thereby increasing the air supply to the grates. Before making the change the draft was about ¼ of an inch at its best.

This change bettered the draft to such an extent that we had not near the trouble in keeping the steam up, but the proper way to have done would have been to increase the hight of the stack.

A. P. SCHMIDT.

Chicago, Ill.

Repairing Broken Crank Shaft

While inspecting the main bearing of an 18x20-inch, inclosed, horizontal, center-crank engine, running at 150 revolutions per minute and driving a 90-inch paper machine, a fracture was discovered at

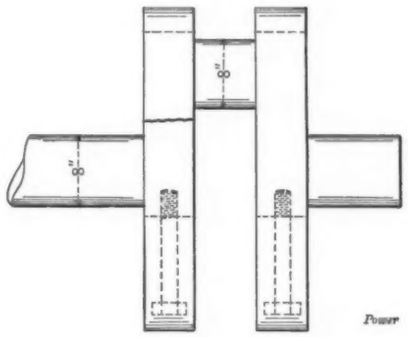
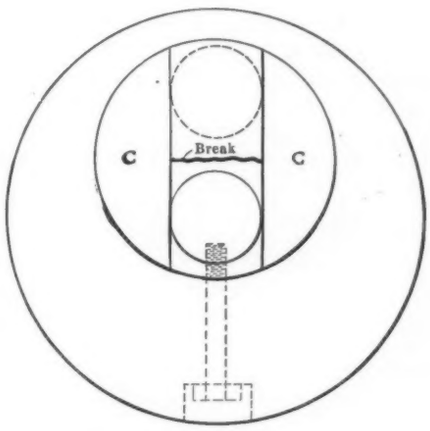


FIG. 1. SHOWING BREAK



Casting A

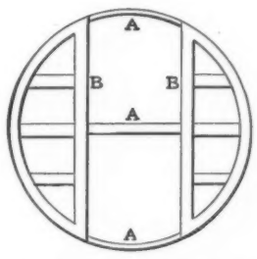


FIG. 2. SIDE VIEW OF DISK AND REINFORCING CASTING

the junction of the crank web and shaft. Closer examination showed the fracture to be a clean break, extending through the web from side to side and completely separating the web and shaft, as shown in Fig. 1. A substantial repair was made in the following manner:

Casting *A*, Fig. 2, was turned to a nice fit with the opening in the balance disk, and then separated into two parts, by breaking away pieces *A, A, A,* and planing faces *B B,* so that each one would fit snugly into the segmental spaces *C C* on each side of the crank slab. Meanwhile a 1¼-inch steel ring had been forged

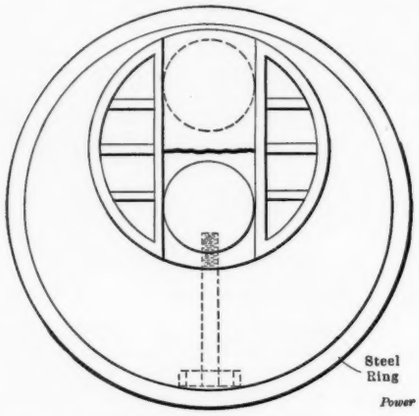


FIG. 3. RING AND REINFORCING PIECES IN POSITION

and bored out for a shrinkage fit over the balance disk.

The shaft was hoisted from the bearings and the disk removed and reduced 2½ inches in outside diameter. After replacing the disk and setting up hard on the cap bolt, we were ready to shrink the steel band in place. The cast-iron segments were put in position, as shown in Fig. 3, and the ring was heated and slipped over the disk.

As the ring cooled and began to nip the disk it closed up the crack so perfectly that it necessitated a close inspection of the break to discern it. The engine was again put in commission and it ran without giving any further trouble until a new shaft was obtained some two years after the accident occurred.

THOMAS MIDDLETON.

East Walpole, Mass.

Testing Surface Condensers for Leakage

It is often desirable to know whether a surface condenser is absolutely water tight. The maker's usual practice is to put a slight water pressure first on one side and then on the other, and watch carefully for any water which may trickle through. The station engineer, if doubtful, will run the condensing plant for several hours with only circulation water going through and carefully notice if any water is thrown up from the condensing coils by the pump. Both of these methods may suffice under ordinary working conditions, but for a close competitive test they will not do. For absolute accuracy, the simple chemical test herein described will be found very satisfactory.

Cooling water is most frequently drawn from rivers, canals, etc., and contains, in greater or lesser quantities, a certain amount of sodium chloride. This, together with the fact that condensed water never contains sodium chloride should enable one to make a very reliable test for any leaks that may be present. To carry out the test we shall require a standard solution of silver nitrate, which is made by dissolving 2.394 grains of pure recrystallized silver nitrate in one liter of distilled water. We shall further require a solution of potassium chromate, made by dissolving one part of potassium chromate in ten parts by weight of water. The latter solution is used as a color indicator. The principle upon which this indicator depends is that silver combines with chlorine in preference to chromic acid. Accordingly no red chromate of silver is capable of being formed as long as chlorides are in the water. But red chromate of silver instantly forms the moment nitrate of silver is in the least excess. Therefore if we take a sample of water known to contain chlorine salts and into this slowly drop the silver-nitrate solution, a white precipitate of chloride of silver will form and continue to do so until all chlorides in the water have been precipitated. But as will be seen on making the experiment, there is difficulty in observing the exact point at which the formation of the precipitates ceases. This difficulty is overcome by the use of the color indicator, the action of which has just been described.

Details of the test are as follows: Measure carefully 40 cubic centimeters of condensed water and filter into a clean porcelain dish. To this add about half a dozen drops of the color indicator, at the same time stir with a glass rod. The color of the water will then be distinctly yellow. Now the silver-nitrate solution, which should be contained in a properly graduated burette, is carefully dropped into the water, which should be stirred constantly. The first few drops become red the instant they touch the water, but quickly die away to a pale yellow on stirring, if sodium chloride is present. The dropping of the silver solution and the stirring should be continued until the water becomes permanently red. At the very earliest point at which chromate of silver begins to form, that is to say, when redness becomes apparent, the addition of the silver solution should be stopped and the amount used ascertained from the burette. From this we can determine the quantity of salt in the water. One cubic centimeter of silver solution practically corresponds with one grain of salt per gallon of water. If, on adding the first one or two drops of silver solution to the condensed water which has previously been colored by the indicator, they become permanently red it is quite certain there is little or no salt in the water, consequently the condenser may be considered absolutely tight. But, if it requires several cubic centimeters of silver solution to bring about a permanent, red color the condenser is certainly leaking and to what extent may be judged by the quantity of salt found to be present.

R. HARBEE.

Birmingham, Eng.

Boiler Feed Pipes

The feed-water pipe of the first boiler that I fired was simply screwed into the front head in the center below the tubes and served as a blowoff pipe. The feed-water heater which was set outside the engine-room door was a box built of 2-inch oak plank and was about 5 feet square by 15 feet long, inside of which was a coil of pipe through which the feed water passed on its way to the boiler. The exhaust steam entered the box at one end and went out at the other. It served its purpose very well, heating the water to about 160 degrees. The boiler was about ten years old when I started to fire it and I worked there for about two years and at that time it showed no signs of leakage or distress. Wood, sawdust and shavings was the fuel used. A handhole plate about 4 by 3 inches in the back head below the tubes was the only means of inspecting the interior below the tubes. It can be imagined what a nice job it was to wash out the boiler, which had to be done every fifth week. I got a good cold-water bath each time, for the method of washing was to start the feed pump (run by a water wheel), let the water go in at the front through the feed pipe and run out through the handhole at the back; and with a swab made of short lengths of pipe with a bunch of rags on the end, things were stirred up on the inside. When the water ran clean from the handhole the boiler was called clean. A boiler set and piped that way today would be condemned at once. Surely times have changed.

In another battery of two boilers which I fired, the feed entered the boiler through the blowoff pipe. They were lap-seam double-riveted and had been in use for 20 years and were replaced by new ones for the reason that the engine could not do its work with the pressure allowed. When taken out they were in good condition, no signs of scale, corrosion, oil or leaks of any kind, showing that they had received the best of care. The return from a heating system was piped to the blowoff and entered the boilers along with the feed water; a thermometer close to the heater showed that the temperature of the water was 205 degrees, but it must have been considerably higher on entering the boiler on account of the return from the heating system which mingled with it. In my opinion feeding through the blowoff in this case was a success on this account.

In another plant the feed pipe entered

through the top of the shell about 9 inches from the front head, dropped within an inch of the top row of tubes and ran back to within about 2 feet of the back head. The first day I was there I went on top of the boilers and when standing there could hear a peculiar noise and feel a slight vibration which I found came from the middle boiler. It being near the end of the week I let it go until Sunday, when I found the inside feed pipe had wasted away and had dropped away from the nipple in the shell and the feed water was being discharged directly into the steam space, and there was a nice big bunch of scale on the tubes directly under where it discharged. Injectors were used for feeding the boilers, without a heater, and the water entering in a steady stream with no pulsations, as would be the case with a pump, did not raise so much disturbance as it otherwise would.

In another plant with four return tubular boilers there was considerable trouble from leakage at the girth seam over the fire. The insurance inspector claimed it was caused by cold water being fed to the boilers during times when the engine was stopped. I found that the feed pipe entered the top of the boiler near the front head, dropped down near the tubes, divided to each side and ran back, discharging directly over the seam. The pipes were run back to within 18 inches of the back head, turned down between the shell and tubes, the leaky seam calked and the trouble from leaky seams ceased.

My way of connecting a feed pipe is to enter through the front head on the side just above the tubes, run back to within 18 inches of the back head, cross over and discharge down between the shell and tubes. This is practically the same way that is recommended by the State law and by the insurance companies.

W. E. SARGENT.

Franklin, Mass.

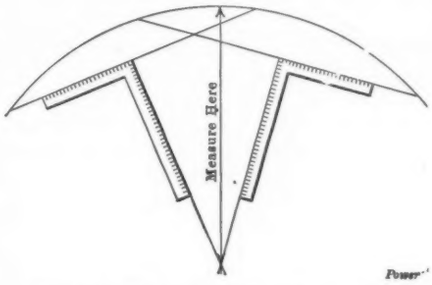
Safe Pressure and Radius for Bumped Head

In nearly all textbooks on the construction and operation of steam boilers, the rule for finding the safe working pressure of a bumped boiler head reads:

Multiply the thickness of the plate by its tensile strength and divide by three times the radius to which the head is bumped.

During one examination I was asked by the inspector how to find the safe working pressure of a boiler head of this type. I quickly repeated the rule, thinking my answer was all that could be desired. The next question was, "How do you find the radius to which the head is bumped?" I was stumped and had to admit it, but on returning home I immediately began to look the matter up and was rewarded by finding the following solutions:

To find the radius to which a boiler head is bumped, square one-half of



FINDING RADIUS OF BUMPED HEAD

chord, divide this by hight of segment, add hight of segment and divide by two.

Another method is: Place the heels of two squares on the centers of two lines drawn from the circumference of the segment to a point near its center: Measure from the point where the lines of the squares cross to the head. This will give radius to which head is bumped.

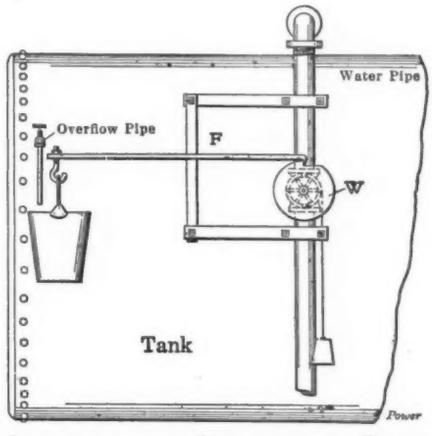
L. C. TUCKER.

Newburyport, Mass.

Automatic Stop on Feed Water Supply Pipe

The return water from our heating system empties into a large tank in the basement from which the boiler feed is pumped.

It is necessary frequently to renew the supply of water in the storage tank from the city main as our laundry apparatus uses up a large quantity of steam, the condensation from which cannot be returned. The main supply pipe is so small that it requires a half hour or more to run in the proper amount. The automatic arrangement shown in the figure makes it possible to open the inlet valve and go away, knowing that the supply will be shut off when the water reaches the proper level.



ARRANGEMENT OF VALVE-CLOSING DEVICE

Referring to the figure, the lever pivoted at *F* engages the notch in the weight wheel *W*. The overflow pipe taps the tank at the high-water level and the overflowing water falls into the pail. The extra weight of the water soon overbalances the lever, which releases the valve wheel and the weight closes the valve.

F. M. MULLIGAN.

Bozeman, Mont.

A Broken Hook Block Bolt

I was visiting a paper-mill engine room, where there was a 20 and 36 by 42-inch cross-compound Corliss engine. While we were talking shop, the latch block bolt on the low-pressure head-end valve broke and the steam valve at the head end remained closed. The engine was carrying a medium load, with a receiver pressure of about eight pounds gage. Of course when one valve on the low-pressure side failed to open, the governor came down, admitting more steam, and as there was only one-half as much going from the receiver as before, the pressure began to climb.

I was surprised to see the engineer take one look and start for the door. In a short time he was back, out of breath, and shut down the engine. By this time the pressure in the receiver was over 50 pounds gage. After he had put in a new bolt and was running again, he explained that the orders were not to shut down without notifying the washer tender, except in case of something serious.

There was no safety valve on the receiver, but there were two 2½-inch relief valves on the low-pressure cylinder. I considered this case serious, for when the receiver pressure was 55 pounds and the relief valve did not open there was a good chance of bursting the low-pressure cylinder. I think there was no need of letting the receiver pressure go so high, or need to shut down so long as one end was working.

I would like to have some of the readers tell what should be done under such circumstances.

A. W. GRISWOLD.

Adams, Mass.

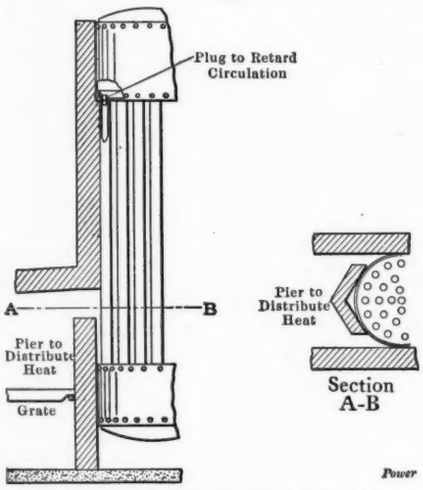
Large mills are to be erected on both sides of the Merrimac river and a dam of immense proportions will soon be built near Mitchell's Falls, between Haverhill and Lawrence, Mass. The power of the big Lawrence dam is taken up by the large number of mills in its immediate vicinity, and it is understood that the Essex company of Lawrence is buying up the land near Mitchell's Falls. There is also a movement on foot to construct a canal across the neck of a small peninsula in the river, from a point opposite Raftery's island, on the Bradford shore, to a point below the lower falls, where there is deep water in the river.

SUBJECTS UNDER DISCUSSION

Comment, criticism and debate upon various articles, letters and editorials which have appeared in previous issues

Defective Boiler Tubes and Their Removal

I was very much interested in the article by Mr. Kennett on "Defective Boiler Tubes and Their Removal," which appeared in December 7 issue. The statement that the water in the lower tubes of a water-tube boiler is flashed into steam so rapidly that it can exist there not in a solid body, but only in a foamy condition which permits the heat to bag



CIRCULATION RETARDERS AND HEAT-DISTRIBUTING PIER

the tubes, is probably correct. I have seen many tubes, perfectly clean internally, bagged after very short usage. I saw an experiment tried which seemed to show that Mr. Kennett's assumption is correct. In a vertical, water-tube boiler, the upper ends of the first row of tubes were plugged with iron retarders as they were called. These retarders had a 2-inch hole through the middle and had the effect of keeping a more solid body of water in the tubes as the terrific circulation through the tubes was retarded. The boiler was used for four months this way and no tubes were lost, while the other boilers of the same installation needed new tubes every few weeks.

I have seen a firebrick pier, such as is shown in the figure, used in vertical, water-tube boiler furnaces to protect the tubes from the fierce heat and to distribute the heat between the tubes more effectively.

I would like to call attention to the short nipples used between the mud drums and headers in some types of horizontal, water-tube boilers. These nipples are usually so short that testing them with a hammer is out of question, and as every boiler inspector knows, the combustion chamber is generally full of wet ashes, which cover the nipples and soon corrodes them, and the inspector gets anything but satisfaction out of an examination.

I once came across a case in which the first row of tubes of a horizontal, water-tube boiler were worn so thin on the top that over half the thickness of the metal was gone. This was due to the moving and rubbing of the tile baffle which rested on them.

Another thing I will mention, is the fact that few water-tube boilers have a tight damper. A veritable cyclone is usually blowing around the tubes, and anything like a thorough inspection is almost impossible on account of the flying ashes and soot which blind and suffocate. Dampers should be made heavy enough to withstand the uptake temperatures which are high and soon warp light dampers into uselessness.

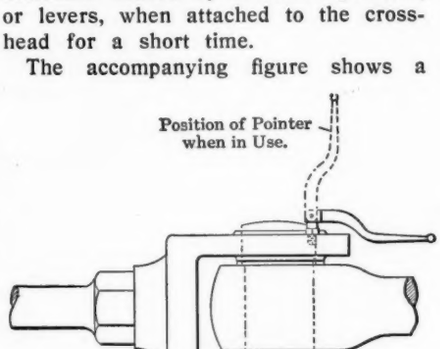
MILTON HEGLIN.

Dayton, Ohio.

Adjustable Pointer for Indicator Cord

I note in the issue of December 28, an article on "Engine Room Safety Appliances" in which attention is called to accidents caused by indicator pointers, or levers, when attached to the crosshead for a short time.

The accompanying figure shows a



POINTER ATTACHED TO CROSSHEAD

pointer which may be permanently attached to the crosshead and is so made that it can be folded in out of the way when not in use.

The crosshead is shown with shoes removed in order to give a clearer view of the pointer. A ball is forged onto the end of the pointer to prevent the hook on the end of the indicator cord from slipping off. The pointer can easily be changed from one position to the other while the engine is running.

C. B. HUDSON.

Lowell, Mass.

A Dangerous Blowoff

R. L. Mossman in a recent number describes and illustrates a dangerous blowoff. I wish to say that if I

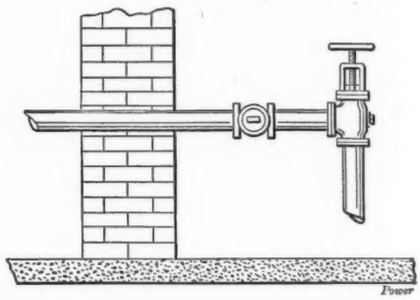


FIG. 1. IMPROVED ARRANGEMENT OF BLOWOFF PIPING

had made the change in the blowoff pipe I would have arranged the piping as shown in Fig. 1. I would have put a cross or tee in the place where the blowoff valve is located in Fig. 2, at the end of the pipe leading from the combustion chamber to the outside of the brick wall. Then a short nipple is screwed into one of the side outlets of the cross and the blowoff valve is screwed onto the nipple. If the boiler does not receive the feed water through the blowoff, a tee

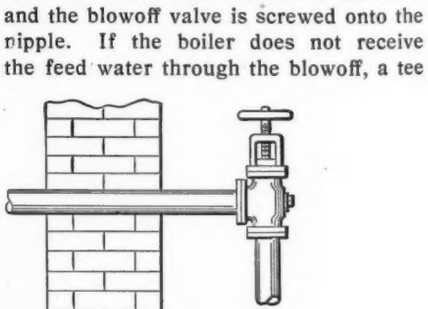


FIG. 2. BAD BLOWOFF CONNECTION

will do in place of the cross. The blowoff valve shown in Mr. Mossman's illustration has a plug back of the valve, the purpose of which is to permit the introduction of a rod to clean out the pipe between the valve and boiler, but I have found that this hole is not large enough to permit of removing a large amount of scale; also the scale will drop into the

body of the valve, clogging it up so that the valve bonnet will have to be taken off to remove the scale. Where the piping is arranged as shown in Fig. 1, the plug can be taken out of the cross or tee and any amount of scale drawn out, preventing the scale from getting into the valve body.

H. JAHNKE.

Milwaukee, Wis.

Double Eccentric Troubles

On page 1009 of the December 14 issue, Mr. Boynton asks if a double-eccentric Corliss engine valve gear should allow steam to pass through the exhaust valve before the steam valve is closed. This condition certainly should not exist.

Mr. Boynton states: "When the governor is down on the safety rest, cutoff occurs at about five-eighths of the piston stroke, but when the governor is let down off the safety rest the valve will remain hooked on and the exhaust valve opens before the steam valve closes and steam passes through to the receiver and to the condenser."

This describes a peculiar condition: First, when the governor is down on the safety rest cutoff occurs five-eighths of the piston stroke.

Second: When the governor is down off the rest the valve will remain hooked on. I infer that he considers this condition correct. Here may be one of the difficulties or this may be a part only. The valves of any Corliss engine, but particularly a double-eccentric Corliss engine, should never remain hooked on, but should be tripped at the limit of their stroke when the governor is on the safety rest.

What appears peculiar is that when the governor is on the rest the point of cutoff is five-eighths of the piston stroke and when the governor is off the safety rest the valves remain hooked on. The fact that the governor is fitted with a safety rest shows that there must also have been safety cams on the trip collars when the engine was built. If the valve is tripped at the point of its full travel when the governor is down on the safety rest, then, when the governor is off the rest the safety cam must hold the valve hook off from the valve-crank catch block.

A study of the statements shows that either one of two conditions exists. The safety cams have been removed or they have been reset at a point further from the trip cams.

I believe that the valve gear is out of adjustment.

All wristplates should travel equal distances each side of their central position. When both steam-valve cranks are hooked on and the wristplate placed in its central position, both steam valves should be open an equal amount. When the crank is on the center and the valve gear all connected, the steam valve should be open the amount of lead desired. The governor should be placed on the rest and the trip collars adjusted so that each steam valve is tripped when it has reached its full travel. The safety cam should now be set up on the trip collar so that when the valve hook reaches its full travel in the opposite direction the point of the valve hook almost touches the safety cam. Now let the governor down full off the safety rest, and the valve hook should not touch the trip cam at all but will touch the safety cam, and hold the valve hook from the valve crank.

The exhaust valves should be so set that with the exhaust wristplate in its central position both valves should show an equal amount of lap. And each valve should open just before the piston reaches the end of the stroke and should close just before the end of the pistons return stroke.

H. W. BENTON.

Cleveland, O.

A Dangerous Boiler

I have read in POWER AND THE ENGINEER many times of boiler explosions and the different ideas of what caused them. I would like to say that I once had an experience that I would not care to repeat and I would like to know why the boiler did not burst. It was installed in a machine shop, and was about 50 horsepower. On casting days it hustled the fireman to hold the steam up to 90 pounds. They had lost a big casting, two heats running, and the foreman came to me and asked if I could fire the boiler and keep steam. I said if the boiler would steam I could keep the steam up. I kept the steam up to 90 pounds and that is all I did do, but they got the casting. I said to the foreman that there was something wrong at the back end of the boiler as to draft and it was leaking badly. The foreman thought not. I knew I was right, so the next morning we went to hunting and found the back arch down, the heat going right up the stack. Then I took out the brick from the dome downward and found a strip the width of the dome extending downward 22 inches. I picked up a ⅜-inch chisel and with a light blow I could drive it through like driving through No. 19 iron.

Now, with 90 pounds steam pressure, what held the boiler together? The steam gage was tested in Cleveland, O., and found in as good shape as they usually are, about one pound off, I don't remember whether light or heavy. I have repaired boilers over 25 years and I never saw anything like that before or since.

C. T. PERRY.

Oil City, Penn.

Puzzle on Piston Speed

Mr. Tallmadge asks a few questions about piston speed. In order to answer same a velocity-distance diagram of the travel of the crosshead pin is drawn.

The point I is the instantaneous center about which the connecting rod tends to rotate for that particular instant.

Let the following notations hold:

V_1 = Velocity of crank pin,

V_2 = Velocity of crosshead pin,

A = Angular velocity of connecting rod.

Lineal velocity equals angular velocity multiplied by the radius of rotation.

In the figure, then,

$$A = \frac{V_1}{IP}$$

$$V_2 = A \times IC$$

Then substituting in the last equation, the value for A in the first, we have,

$$V_2 = \frac{IC}{IP} V_1$$

and from the diagram, it will be seen that,

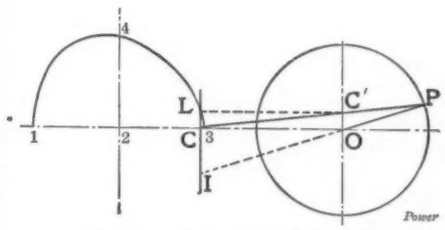
$$\frac{IC}{IP} = \frac{OC'}{OP}$$

being ratios of sides of similar triangles.

Therefore, as

$$\frac{V_2}{V_1} = \frac{OC'}{OP}$$

the construction in the diagram is correct and all vertical lines such as C—L,



VELOCITY-DISTANCE DIAGRAM

2—4, etc., may be taken to represent the varying velocity of the crosshead pin.

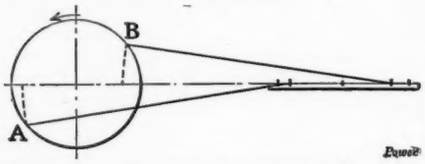
Now if all the vertical lines represent the instantaneous velocities of the crosshead pin and the line 1—3 equals the distance traversed, we may find the average velocity of the crosshead pin by dividing the sum of all the vertical distances; that is to say, the area of the diagram, by the length. In the same way the average velocity for any section of the stroke is found. If we take the head- and crank-end halves for comparison, by inspection we know that the area at the head-end half is greater than that at the crank-end; but the distances traversed, 1—2 and 2—3 are equal. Hence the area of the head-end half divided by half of the stroke is greater than that of the crank-end half divided by half of the stroke, and thus the average velocities

are shown to be different for each half of the stroke, that for the head-end being greater than that for the crank-end.

G. A. GLICK.

Madison, Wis.

Referring to the accompanying cut, we note that the crank pin has traveled an equal distance from the center line at both *A* and *B* but the distance which the crosshead has traveled is greater in one instance than in the other. We see that if the crank moves at a uniform speed the piston leaves the head end of the cylinder considerably faster than it does the crank end. This is sometimes said to be due to the angularity of the rod,



CROSSHEAD TRAVEL FOR EQUAL ARCS AT OPPOSITE ENDS OF STROKE

which is a wrong idea, as we have the same angularity of rod in both positions.

The true cause is found at the crank. If we disconnect the rod from the crank pin and swing it back to the center line, the end of the rod will scribe the arcs indicated by the dotted lines. We find at *A* the piston has traveled the hight of the arc of the crank-pin circle, less the hight of the arc scribed by the end of the rod, but at *B* it has traveled the hight of the arc of the crank-pin circle plus the hight of the arc scribed by the end of the rod. At *A* the arcs curve together, at *B* apart. This should be clearly understood, as it is of great importance in valve setting, and the shorter the connecting rod is in proportion to the throw of crank the greater will be the difference.

J. R. MORTON.

Detroit, Mich.

If a person will make a sketch of the crank and crosshead or refer to the sketch accompanying the article under discussion, it is very easily seen that when the piston is at mid stroke the point around which the crank revolves and the point connecting the crank and connecting rod are the same distance from the crosshead and therefore the crank makes equal angles with the center line of the engine and with the connecting rod. If we brush the cobwebs off of our geometry we will remember that all the angles of an isosceles triangle are less than 90 degrees; hence the angle which the crank makes with the center line of the engine at mid stroke is less than 90 degrees, and the angle turned through in the head-end cycle by the crank is less than 180 degrees, from which it follows that with uniform angular velocity it will take less time for the piston to move through the head-end cycle than the crank-end cycle.

HARRY KAHN.

New York City.

The piston of an engine travels more rapidly through the half of the cylinder at the head end than it does through the half at the crank end. The difference is due to the angularity of the connecting rod. *A* and *C* represent the ends of the stroke and *B* the center. While the crank pin is traveling half way from *F* to *G*, or distance *H*, the piston travels more than half way from *A* to *C*, or distance *D*. Consequently while crank pin travels distance *I* the piston travels distance *E*.

Assuming there is no irregularity in the movement of the crank pin, the piston moves distance *D* in the same length of time that it moves distance *E* which shows that the piston travels faster through the half of the cylinder at the

DIAGRAM OF CYLINDER AND CRANK ARM

head end. The same is true on the return stroke.

W. E. STOUT.

Chicago, Ill.

How Shift Changes Waste Money

Mr. Whitham's letter on "How Shift Changes Waste Money" has aroused a considerable amount of criticism as he probably expected it would; however, he is right in his contention that change of watch is usually attended with neglect. The figures given are excessive and in a plant of such capacity no such methods would be allowed to go on, but the routine of making the change as outlined is not far from correct. The men on watch will wash and dress early to take advantage of the possibility of their relief being ahead of time; next in order is a visit, followed by the departure of the outgoing shift and the preparations of the incoming shift to take the watch. This not only applies to the boiler room but to all parts of the plant, resulting in actual waste in the fire room and poor service elsewhere. The remedy is not shorter hours or better pay, but in better supervision, especially when the watch is changing. The writer is an advocate of an eight-hour day and well paid men, but this is a condition which is often beyond the power of the engineer to change and it is incumbent on him to operate intelligently and economically with what is provided.

Even in a properly managed plant there will be a greater tendency to neglect the service at relieving time and many companies recognizing this fact have arranged the watches so that the entire shift does not change at one time.

I have noticed that in a great number of plants, some of them large and where men were well paid and the hours short, the tendency to wash and dress on "company's time" and to hurry home when the next shift arrived was as great as in places where the men labored under adverse conditions.

Considering the danger and responsibility of power-plant work, the employees should have reasonable hours and suitable pay, but in any case proper supervision is necessary to obtain efficient operation.

LEWIS C. REYNOLDS.

Willard, N. Y.

Experience of a Trouble Man

On page 1036 William Westerfield gives an account of some experiences. Reading the article carefully, I have decided that he owes some explanations.

The diagram shown by Mr. Westerfield shows clearly that the exhaust valves were working correctly, excepting that the closing was a little too early, resulting in too much compression; yet he states that the valves also opened just at the point of cutoff, allowing the live steam at boiler pressure to pass into the receiver. This means that each exhaust valve opened and closed twice for each stroke of the piston or four openings and four closings of the exhaust valves for one revolution of the engine.

I do not quite understand how exhaust valves can be adjusted to show so nearly ideal conditions and yet have a second opening and closing as stated and shown by Mr. Westerfield.

I would like to know why this leakage of boiler pressure to the receiver does not affect the receiver pressure, and show the change of pressure on the high-pressure diagram exhaust line.

After the fault in the adjustment of the valves was corrected he shows the diagrams secured. Comparing them with the first set, it appears that the same spring was used in both high-pressure diagrams, also the same spring was used for both low-pressure diagrams. The second high-pressure diagram shows that the receiver pressure is about one-half that shown by the first high-pressure diagram, yet the second low-pressure diagram shows that the receiver pressure is almost exactly the same as that shown by the first diagrams. He states that the vacuum was 26 inches instead of 25 inches when the second low-pressure diagram was taken, yet by comparison the second diagram shows the opposite. By comparing the two sets

of diagrams, the only change to be seen is that the release for the head end of both cylinders has been made earlier. The compression for both ends of the high-pressure cylinder appears to have been reduced slightly and compression for the low-pressure cylinder equalized and slightly increased. The admission and point of cutoff are clearly shown, in fact, even for a high-class Corliss engine they are exceptionally sharp corners.

My opinion is, after a careful consideration of the diagrams shown, that the diagrams were drawn free hand, and that the condition as stated did not exist.

About the only explanation that can be offered would be that the exhaust valves overtraveled or that a shoulder had been worn at the ends of the valve travel and the valves were forced up on this shoulder, raising the valve off its seat, allowing steam to blow under the valve into the receiver.

HARRY W. BENTON.

Cleveland, O.

A Faulty Heating System

A young engineer called my attention to A. J. Dixon's article in the December 7 issue under above title. The communication appears at an opportune time, as my young neighbor is greatly bothered by the presence of excessive moisture in the compressed air which he supplies to some tenants for jewelry-enameling purposes.

The installation of the remedy recounted to us in Mr. Dixon's letter, viz., running two 130-foot lines of 1½-inch pipe to the ninth floor of the building would, in our case, be expensive and inconvenient. I had previously advised my friend of a somewhat more convenient method. It being based on a rather limited experience with the subject, I would be glad to get comments from other practical men.

Mr. Dixon will allow, I believe, that any water which may be liberated after passing the separating tank on the ninth floor, will be carried with the air to the thermostatic system, therefore the separation of the air and water takes place in the 130 feet of one and one-half inch pipe between the receiver and the separating tank. If this conjecture is right, then might not the tank be placed on the same level as the receiver, and the piping carried to the fourth floor only and back again, thus eliminating 130 feet of 1½-inch pipe and its attendant cost of installation, and also 130 feet of probably ½-inch drip pipe.

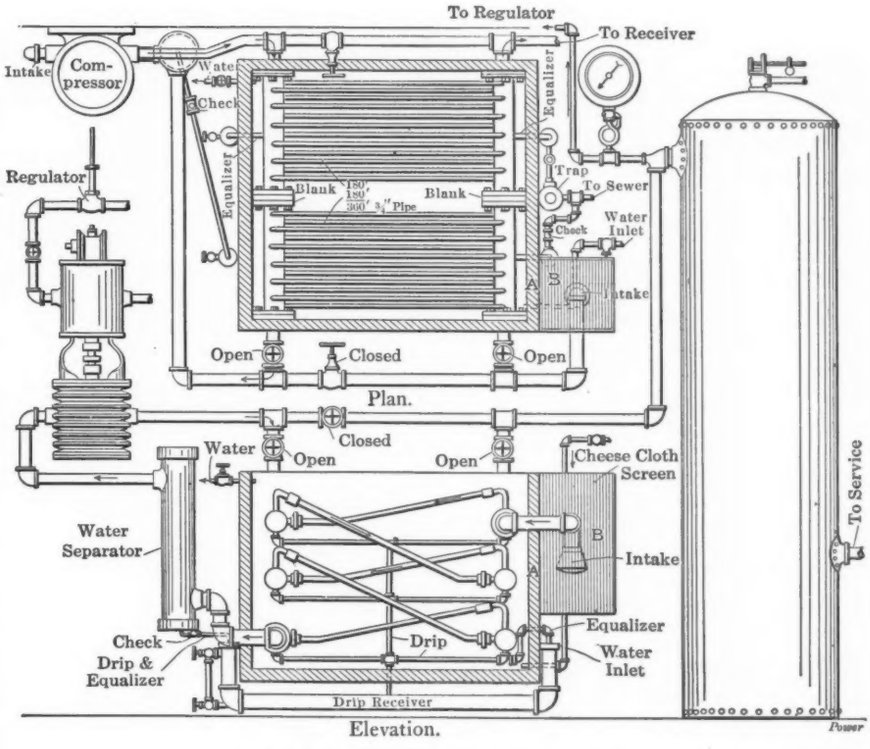
Another point, based perhaps on fallacious reasoning, that may be advanced for placing the separating tank on the ground floor is that air under pressure is lighter than steam. Might we not argue that the most humid air will be found at the lowest level, and therefore the separating tank would find more water to separate on the ground floor, presuming, of course, that we utilize 130 feet of piping only. Summing up, it seems to me that Mr. Dixon's scheme is simply to supply sufficient cooling surface to condense the moisture in the air. On this same principle I once experimented with air used to blow out generators in a large power station. The air was so moist that instead of blowing the dust from the armature and fields, it amalgamated it into a paste. We passed the air pipe in several coils through the large central suction well of the condensers, in an attempt to condense the moisture by cooling. The result proved fairly satisfactory.

On this single experience, and a knowledge of the fact that a considerable quantity of water collects in the intercooler between the cylinders of a two-stage compressor, I presumed to advise the young engineer and drew out the plans shown in the illustration. We would be pleased to hear from anyone having practical experience in remedying the same trouble. An apparatus built on the principle of a steam separator would not, in my estimation, be effective, as but little, though constant demand is made on the compressor, and therefore the air velocity is very low.

Referring to the figure, it will be noticed that the wooden tank *A* acts as a precooler as well as an aftercooler. The plant is located in the basement. Owing to the proximity of adjoining buildings it is impracticable to carry the intake pipe outside, and the consequence is that the incoming air is at the temperature of the engine room, which is seldom below 85 degrees Fahrenheit. It is expected that the precooler will lower this temperature 10 degrees, thus adding 2 per cent. to the efficiency of the pump, in addition to condensing a considerable quantity of the moisture. For filtering purposes a cheese-cloth covered wire screen of ample dimensions will be used as shown at *B*. The cooling water is the additional water from the city mains required to feed the boilers. The figure needs no further explanation except that to prevent unnecessary complications the plan and elevation have not been made to coincide.

H. P. EVERETTE.

Boston, Mass.



PLAN AND ELEVATION OF HEATING SYSTEM

A Broken Bedplate

Referring to D. A. Jamison's article in the December 7 issue, it would appear that if the frame was made proportional to the thickness given, the design was O. K. The manner in which the fracture occurred would lead me to believe that it must have been partly fractured by a previous shock. Had the frame been O. K. beforehand, I think other members of the engine would have taken care of the 1/16-inch clearance in the engine cylinder.

The fracture occurred where the greatest strain is located in a frame of this type.

T. J. HAMMERSLEY.

Milwaukee, Wis.

Marine Cylinder Practice

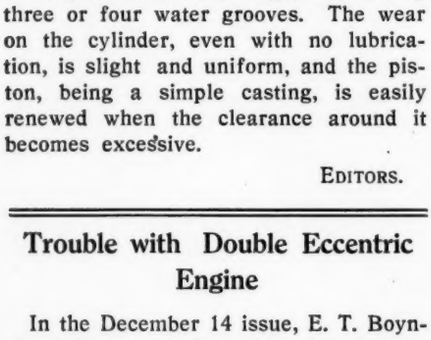
An engineer in charge of a line of ocean-going steamers discussing cylinder lubrication the other day assured a representative of POWER that in all the cylinders upon his boats, including the pumps and auxiliaries, no oil nor other lubricant is used. The most that they do is to put in a very small amount of light oil as a vessel is making port in order to prevent the rusting of interior surfaces while standing. He corroborates what has been frequently said, that a cylinder which has been once run with oil requires careful weaning, and that it will not do to change abruptly from oiling to running without oil. He uses semi-steel liners in his cylinders and, for diameters of 20 inches and under, solid pistons without rings, but having three or four water grooves. The wear on the cylinder, even with no lubrication, is slight and uniform, and the piston, being a simple casting, is easily renewed when the clearance around it becomes excessive.

EDITORS.

Trouble with Double Eccentric Engine

In the December 14 issue, E. T. Boynton asks a question about his double-eccentric engine.

A double-eccentric engine is capable of many more changes than a single-eccentric. The exhaust valves can be advanced independently of the steam valves, and in the case in question, it may be that the exhaust valves were not set line and line when the exhaust wristplate was central, or that exhaust eccentric was set too far in advance, making compression and release earlier as shown



EARLY COMPRESSION AND RELEASE

by the diagram. As the engine, when being shut down takes steam full stroke, it is apparent that steam can blow through into the condenser.

The only advice to be given, is to put the exhaust wristplate on center, set exhaust valves line and line and give the exhaust eccentric a slight advance in the direction the engine is running. This will give release a little before the end of the stroke. If it is desired not to release until the end of the stroke, lap should be given to the exhaust valves while the wristplate is central.

A. C. WALDRON.

Lynn, Mass.

Cylinder Lubrication

I have read with interest your call for information on cylinder lubrication and have been watching each issue for the appearance of the data. In the plant of which I have charge, we use Twentieth Century cylinder oil at the present time.

In our 14x15-inch Skinner, high-speed, automatic-cutoff engine, running 267 revolutions a minute, we use four drops of oil per minute.

In our 10x12 Skinner, high-speed, automatic-cutoff engine, running 300 revolutions a minute, we use three drops a minute.

In our 165-horsepower, Russell engine we use four drops per minute.

M. C. REYNOLDS.

Carey, O.

Belt Lacing

In a former issue the question of belt lacing, wire or rawhide, was discussed. At that time I was conducting an experiment. I have now satisfied myself that wire is superior if properly applied. Here is the experience: A 12-inch double belt running 75 hours per week and transmitting 40 horsepower is running nearly horizontally over 24-inch pulleys, 15 feet centers. First I tried soft iron wire. This would break and the broken ends would slip out. The same thing happened to brass wire which I annealed before using. I then tried a patent wire which is made for the purpose and which comes in different thicknesses suitable for different-sized belts. This stayed somewhat better when the directions for applying were followed, but would not run over a month.

The method which has solved this question for me is this. Opposite each hole I cut a groove the width of two thicknesses of wire and slightly deeper than one thickness. I then lace the belt twice through and am careful not to kink the wires and not to cross them and to lay them parallel in the groove and to pull up tight; after lacing, hold up on the back outside of belt with a piece of smooth, flat iron and gently hammer the wires down in the groove. Then apply a thick belt dressing freely to the joint. This belt dressing seems to protect the wires from friction and to lubricate a little. This belt so laced has now run two years without attention and the joint looks so good, flat and smooth, that in my opinion it would go on a dynamo and I would not expect the joint to cause a flicker of the lights and it seems the only joint nearly approaching the endless belt. One thing I noticed. If the wire is nicked by the pliers or hammer, or in any way, it will surely break in a short time. This belt runs on iron pulleys.

HAROLD JAMES.

New York City.

Engine Cylinder Can Act as Pump

In the issue of December 28, Mr. Petersen says he does not believe an engine can act as a pump. The way for an engine to act as a pump is for it to produce a pressure in the cylinder less than that in the exhaust pipe. To do this it is simply necessary to cut off the steam supply and let the engine run on its own momentum. If this is done a vacuum will be formed in the cylinder and receiver unless there is a way for air to get into the receiver after the pressure falls below that of the atmosphere; thus the engine will act as an air pump.

Suppose the low-pressure piston to have made the outward stroke and caused the pressure in the receiver to fall below that in the exhaust pipe, as the piston reaches the crank end, the head-end valve opens for release and the pressure in the exhaust pipe being greater than that in the cylinder, any water trapped in the exhaust is carried into the cylinder if the lift is not too great.

While this is not the principle upon which a pump acts, I think Mr. Petersen will see that a condition can be produced whereby water may be drawn into the cylinder.

C. B. HUDSON.

Lowell, Mass.

Effects of Oil

On page 966, December 7 issue, F. H. Williams mentions engines running without cylinder oil and others where the oil could not be stopped or cut down.

In my railroad days I was on a branch where my train had to do all the switching at the terminals as well as on the road and I was the fellow that had to jerk the throttle for all that work.

In those days the throttles were slide valves and the lever was partially supported by the guide for the throttle lever clamp. This guide had never been oiled and the lever slid back and forth leaving a smooth surface.

One day I put some oil on it and forgot about it.

Some days after this I noticed the lever working as though some new obstacle had appeared and examination showed this guide to be cutting. The oil had made a finer surface and after it was entirely gone, cutting commenced. I have noticed similar things in other cases.

After using oil there are cases where a discontinuance has not resulted in serious trouble other than groaning, but there is cause for apprehension.

W. E. CRANE.

Duluth, Minn.

Life of Victor Dwelshauvers-Dery

Victor Dwelshauvers-Dery was born at Dinant, Belgium, April 25, 1836. He was a cousin of Charles Darwin. Of aristocratic birth by his mother, he unites a delicacy of sentiments to the love of liberty and the energy that he derived from a very democratic father. When 17 years of age he went to study for four years at the institute of M. Dupuich, of Brussels, entering there into the higher mathematics. His mind displayed a leaning toward the actual and practical, which influenced him to go to the School of Mines in the University of Liège, where he took the degree of Mechanical Engineer in 1861. Directly, he was appointed to a position as instructor in mechanics at the university, and subsequently acquired a full professorship, which he retained permanently. In this he succeeded Brasseur, a famous teacher of applied mechanics under whom he had studied.

There was then little instruction given in such subjects as resistance of materials, graphical statics, thermodynamics and the theory of the steam engine, but they were introduced by Dwelshauvers-Dery into the curriculum. He was anxious to compare theory with practice and devoted much attention to original investigation. At the London Exhibition, in 1862, he was greatly impressed by the Porter-Allen engine and forthwith purchased a novelty which Mr. Porter had shown in connection with it—a Richards high-speed indicator. This the buyer long lacked facilities at his school to use.

From 1870 on, he sought to establish an engineering laboratory for his students, but was a great while in getting it. He visited Hirn, in Alsace, and made use of an engine of that distinguished scientist for investigating the discrepancy between the pure thermodynamometric and the correct, applied theory of the steam engine. Among the phenomena which he approached by new methods of study at Liège were those of steam condensation. About 1880 he was allowed an appropriation with which he purchased an engine for experimental laboratory work, but at first was under the necessity of keeping it outside of the university, at his own expense. It was not until 1893 that the university granted him the mechanical laboratory he desired. To his influence may be ascribed the fact that steam laboratories were already being established by other institutions. From 1894 systematic work was conducted in his, and it was fruitful of results. The first years of research tended to show the possible usefulness of steam jacketing and of superheated steam and emphasized the importance of dry steam. One of his greatest accomplishments has been to determine anew, with an engine of commercial size, the mechanical equivalent of heat.

From 1897 onward, Dwelshauvers-Dery devoted himself entirely to work in the mechanical laboratory which by his good judgment had been established at the University of Liège. The publication of the methods employed and the results already attained, clearly showed the great service which a well organized mechanical laboratory may render to education. The pupil sees with his own eyes how things work out in practice and how sometimes they differ from theoretical predictions which have not taken account of all the facts.

According to the method of Dwelshauvers-Dery, when testing an engine, all the observations of the instruments were made by a group of a dozen students, each having his duties clearly determined beforehand, readings being recorded every minute or every two minutes, etc., in a notebook prepared for the purpose. Every precaution was taken that the test proper did not exceed an hour or an hour and a half, which contrasts with the hours of time generally occupied in such purposes in school laboratories.

VICTOR DWELSHAUVERS-DERY

If the task of the student had been limited to the observation of an instrument every two minutes, during one or two hours, he would have derived little profit from the time devoted to laboratory exercises. Indeed, by the method of Dwelshauvers-Dery, the noting down of data direct from experiment, although indispensable, required only a minimum of work. The test having ended, each observer dictated to the others the entire series of his notes. Thus, each was in possession of a book containing the complete table of all the data from which might be derived the results of the test. The handling of these data comprised a solution of some 50 numerical problems to be worked out at home. Such was the true exercise proper to form an engineer; for the system of recitations adopted at Liège does not call out the initiative of the pupil and hardly does more than exercise the memory. Besides, problems based on data which are beyond the observation of the pupil, and sometimes fanciful, may lead to improper and deceptive results. It is in the solution of problems having real data, taken on the alert, that the usefulness of a mechanical laboratory consists. The case is different in other laboratories, chemical ones, for example. There the entire work is done by one person, in the laboratory itself, and comprises the few numerical calculations required to specify the results of the analysis; while in the mechanical laboratory, the spirit of observation of the pupil is really exercised. In a steam-engine test one man is unable to see or note all the phenomena that influence the conclusions; these must be reached by knowing and comparing the data from all the observations and by long work carried on with a rested head, in the silence of the office.

The method of Dwelshauvers-Dery places the professor in a position to realize the desire of Hirm, that the students might be made useful in new discoveries. From 1873, he had proposed the question: "Is the compression of steam in the clearance space at the end of the return stroke economical?" For purely theoretical reasons, with numerous engineers, he believed in its economy; but he desired experimental confirmation by judiciously arranged tests. With a view to solving this question and others of like nature, he caused to be constructed a purely experimental engine, which was flexible in its adjustments, permitting at pleasure separate changes of all the events of governing and steam distribution. For example, the degree of compression might be varied, everything else being kept the same. To the great surprise of the professor, a first long series of tests showed that compression was the more costly the higher it was carried. He was unwilling to believe in this result until after having made further series of tests with some of the conditions changed.

After having described his method of experimentation, he imparted to the

public his researches upon final compression. His articles aroused the praise of some engineers and criticism of others. Some even tried to discredit the laboratory tests at Liège, suggesting that there had been piston leaks, shown by a hook at the end of the indicator diagram. The professor was convinced by experiment that there had been no such piston leak. When put in possession of all the original documents, Commodore Isherwood, formerly engineer-in-chief of the United States Navy, who had desired to take up the question, affirmed with all his authority, the absence of a piston leak. Finally, Georges Duchesne, a pupil and collaborator of Dwelshauvers-Dery, put an end to the discussion of this subject by a decisive experiment.

The professor attributed the hook at the end of the diagram to condensation produced by compression; and he gave as proof diagrams taken upon Allis engines which showed the final hook and which certainly had not been affected by piston leaks. G. Duchesne, to settle the question said: "If the hook be due to condensation, it will not appear in case we compress air, which is not condensable." He experimented with air and no hook appeared in the diagram.

Dwelshauvers-Dery then demonstrated experimentally that the law of expansion is by no means the same as that of compression.

Pursuing the investigations, Georges Duchesne decisively showed that generally the steam is superheated at the moment when exhaust ceases and compression begins; that afterward the superheat is lost by the action of the cylinder walls and that in certain cases the steam rapidly condenses before the end of the stroke, this resulting in a hook.

Partly, at least, upon the basis of other investigations, Dwelshauvers-Dery had laid down the following principle, later confirmed by experiment: "The most economical operation of the steam engine is secured when, by any efficient means, whether jacketing, superheating or other, the cylinder wall is brought to a condition of perfect dryness at the beginning of the exhaust period."

A later enunciation was as follows: "The less the quantity of water remaining on the surface of the metal of the cylinder wall at the instant of opening the exhaust passage, the less the consumption of steam by the engine. When the ratio of expansion is varied from one to another extreme of values, it will be found that the measure of steam consumption and of efficiency will pass through a series of values also, giving a minimum cost of power and maximum efficiency of steam employed at a point which corresponds to that at which this condition of final dryness of the cylinder wall is secured."

Hirn's calorimetric analysis of the steam engine was put into systematic algebraic form by Dwelshauvers-Dery.

In 1900 the professor was interrupted in his work by the obligation to perform for three years the absorbing function of rector of the University of Liège. Justified by such a service, at the end of this lapse of time, he retired.

Before long, however, changes were introduced into the methods employed at the mechanical laboratory which, he believed, seriously compromised its usefulness, and theories advanced which he did not approve. With health recovered after a period during which he was physically incapacitated for work, he again appeared publicly as a champion of his convictions. Two controversial letters from his pen were published in 1907 and 1908, in the *Bulletin de L'Asson. des Elèves des Ecoles Spéiales de Liège;* finally, in 1909, an article on the conception of "Work." In 1908, he had also published the *Revue Générale des Sciences*, an article on the conception of "Mass."

In 1905, in connection with the Mechanical Congress of Liège, he had been appointed to prepare a *mémoire* on the mechanical antiquities of Belgium and especially upon the famous hydraulic machine of Marly, erected under orders of Louis XIV by Renkin of Liège; and the same year he edited a historical report on the mechanical progress of Belgium from 1830 to 1905.

In 1888 he was awarded by the British Institution of Civil Engineers, the Telford prize for his discussion of the steam-engine governor. In 1889, he shared with Donkin a prize for successfully investigating the thermal action of the interior of the cylinder wall. Among the societies with which he was connected was the A. S. M. E., which made him an honorary member in 1886.

The late Dr. R. H. Thurston, who knew Dwelshauvers-Dery well, held both the accomplishments and the character of the man in high admiration.

Oxyacetylene Welding for Power Plants

Some interesting work has been done by the Chicago Welding Company in the plant of the First National Bank building, using the Davis-Bournonville oxyacetylene process of welding. The cast-iron threaded flanges on a portion of a steam header were welded to the pipe, making a permanent steam-tight joint, and a boiler seam which had been repeatedly calked to no avail was easily welded in place, demonstrating how this process may become an exceedingly valuable aid in solving some vexatious power-plant problems.

In welding cast iron by this method the metal becomes sufficiently fluid to have a smooth surface and in a molten state it flows very much like mercury; that is, it hangs together in balls. These balls have to be broken up by what is termed scaling powder, which is used in much the same manner as a flux in brazing. The portable torch used in applying the enormous temperature of 6300 degrees Fahrenheit, developed in this process, consists of two small pipes or conduits terminating at one end with hose connections, the other ends connecting in a recessed head that receives the torch tips, which are interchangeable according to the work to be done. The pipe for acetylene is screwed into a cylinder about 1½ inches in diameter, which serves for a handle and is packed with porous material that prevents the possibility of communicating a flame beyond this point. Hose cocks are fitted into the rear of the torch and these are made with nuts so that wrenches may be used without injury to the cocks themselves. The hose connections are fitted to these cocks with unions so that they can be readily detached and connect to portable tanks of oxygen and acetylene gas.

In welding the cast-iron flanges it was necessary to take down the pipe and preheat the flange, as cast iron and steel have different degrees of expansibility. Steel does not become so fluid as the majority of metals, however, and can therefore be worked in any position, so that steel flanges can be welded without disconnecting the pipe.

In the process of welding as carried out with a blow torch the junctions of metals to be united are neither lap nor butt joints, as in ordinary welding, but are chamfered off if not already of a form which permits the penetration of the flame to the remotest parts of the surfaces to be welded together. There is then added to the joint, after it is itself in a running condition, drop by drop, molten metal from a rod or special wire, used the same as a stick of solder. It is usual in welding two like metals to use a solder stick of the same material.

For boiler work the process presents some interesting possibilities. Welded with a soldering material of a composition equal to the plate itself, a joint usually shows an efficiency of 86 per cent., while by using a better grade of material for the soldering element the efficiency may be increased even beyond the strength of the plate itself.

A test of a piece of boiler plate with two different welds was made by Crane Company, one using a solder of the same material as the plate and the other using vanadium steel. The efficiency of the first was found to be 86 per cent. and of the second, 103 per cent. of the strength of the plate.

Heating and Ventilating Convention

The American Society of Heating and Ventilating Engineers held its annual meeting in New York at the Engineering Societies' building on January 18, 19 and 20.

At the second session, on the evening of January 18, the report of the joint committee consisting of the committee on "Standards" and the committee on "House-heating Boilers" together with President Snow, acting ex-officio, was presented. This committee was appointed at the annual meeting in 1909, and instructed to submit a method for rating steam and hot-water heating boilers which would be acceptable as a standard.

The society has been striving for a long time to secure a standard of rating which would be satisfactory alike to manufacturers, engineers and purchasers. The report of the minority of the committee was also presented as was a letter of objection to the majority report, written by Committeeman E. D. Densmore. After a lengthy and very animated discussion, it was voted to receive both reports and refer them to a new committee to be appointed by the president-elect.

At the fourth session, which was held on the morning of the twentieth, Prof. William Kent presented his paper on "Performance of Heating Guarantees." The paper describes a simple formula, originated by Mr. Kent, which may be employed to reduce test results to terms of the guarantee when the test is conducted during weather other than that described by the guarantee. It is customary to specify that the builders shall guarantee the heating apparatus to be capable of maintaining a given temperature inside when the outside temperature is, say, zero. The builders naturally want to be paid as soon as possible after the work is completed. Zero weather may not occur for a considerable period after the apparatus had been installed. By using a reliable formula the results of a test conducted during weather reasonably near zero may be used to indicate the extent to which the apparatus conforms to the guarantee.

The formula is,

$$T_1 = \frac{T_s + C T_o}{1 + C},$$

T_1 = Temperature to be maintained inside,

T_s = Temperature of steam or water in radiation or coils,

T_o = Temperature outside,

C = Constant found by solving the equation,

$$C = \frac{T_s - t_1}{t_1 - t_o},$$

where t_1 and t_o represent inside and outside temperature specified in the guarantee.

Professor Kent's formula has been found reliable for outside temperatures ranging from —10 to 40 degrees Fahrenheit. The other papers presented were: "A Method of Determining the Sizes of the Pipes of a Hot Water Apparatus," by J. Jeffreys; "Variability of Interior Conditions in School Rooms," by H. W. Whitten.

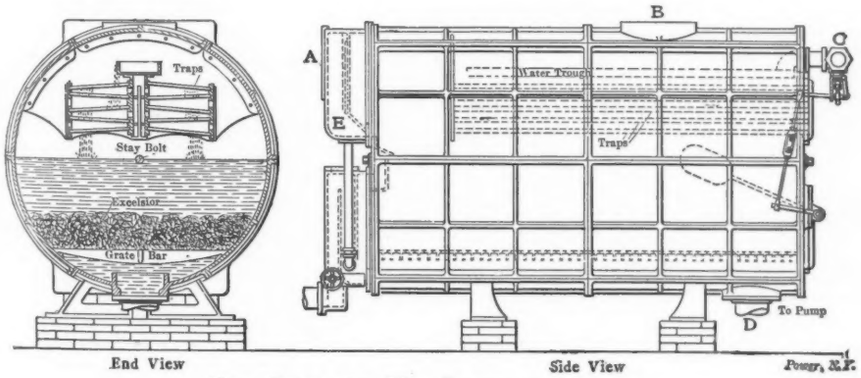
Twelve topics of interest in heating and ventilating work were discussed. Reports were received from committees appointed to review the proceedings of the society with respect to various phases of heating and ventilating work. These reports briefly describe all transactions of the society bearing on the subjects which the several committees were appointed to review. The reports are extremely valuable to anyone wishing to investigate any of the subjects treated.

At the last session, the following officers were installed to serve during the current year: J. D. Hoffman, president; R. P. Bolton, first vice-president; S. R. Lewis, second vice-president; William M. Mackay, secretary; U. G. Scollay, treasurer.

Excelsior in Open Heater

A method of adding extra precaution against oil getting into the boilers at the Marion plant of the Public Service Corporation of New Jersey is in use and consists of the substitution of excelsior for coke, the usual filtering medium. The illustration shows an end and side view of one of them; also the method of applying the excelsior.

As shown in the end view, grate bars are laid across from one side of the heater to the other its entire length, being spaced at proper distances. Upon these grate bars is placed wire screening having a ⅝-inch mesh, upon which is placed cheesecloth. Next comes 6 inches of excelsior, then another layer of cheesecloth, which is covered by another layer of ⅝-inch mesh wire screening, which is held in place by more old grate bars, suitably spaced, not shown.



How Excelsior Was Placed in Heater

The heaters, three in number, each having 10,000 square feet of heating surface, take care of the feed water for twenty-five 600-horsepower water-tube boilers, and are so piped that either one can be cut out of service, the remaining two doing the work. The heaters are of longitudinal cylindrical construction. The exhaust steam enters at *A* and escapes at *B*. The feed water enters at *C* and, after passing over the traps or trays, suspended in the interior, is drawn out through the outlet *D* to the boiler-feed pump.

It will be seen that all oil not taken care of by the oil separator *E* must filter through the excelsior before it can get into a boiler. As the excelsior readily holds any oil that may come in contact with it, trouble from excessive oil is reduced to a minimum.

Since publishing the description of the De La Vergne, type "F H," crude-oil engine, page 194, January 25 issue, in which it is stated that the oil consumption per brake horsepower is from 0.4 to 0.45 pound per brake horsepower-hour, also that an installation at Smead & Co.'s iron works, Jersey City, ran on a fuel cost of 27 cents per kilowatt-hour, we have been informed that, while these figures are correct, it remains to be said that the engine was running on a load factor of only 30 per cent. The engine ran 162 hours with an average load of less than one-third on a fuel consumption of 0.57 pound of oil per brake horsepower, which would indicate that at full load it would show a higher efficiency than indicated in the descriptive article.

Some Pointers on the Centrifugal Pump

At the regular meeting of the Western Society of Engineers held at Chicago, January 19, William R. Wiley read a paper on centrifugal pumps, treating of the scope and application of this type of pump to engineering problems. Regarding the design and peculiarities of single- and multi-stage pumps, Mr. Wiley's paper ran in part as follows:

The average engineer is not interested in the actual evolution of formulas of design and it is not the intention to take up this phase of the subject in detail. The design, however, should be such that the efficiency will be maximum at the capacity of the pump when operating against a given head. Test reports and experience have shown that the best results are obtained by the use of a velocity of 8 to 10 feet in the casing and through the pump. This velocity may be increased for high lifts per stage. With the velocity within the limits above stated the best efficiencies are obtained and this velocity in itself determines the size of pump to be used for a certain capacity and also the range of adaptability of a given pump casing. Due to commercial considerations, therefore, and the necessity of having standardized designs, each individual size of casing must be constructed for an average of the service which it must perform.

The open impeller has only a limited application. It finds its best field in low-lift pumps of single-stage type, and even on these low lifts, the efficiency of the inclosed type more than counterbalances the increased cost of construction. There are certain classes of rough work such as are met in contracting, where the open impeller pump presents the best solution. Past experience shows that it is inadvisable to design a single impeller for a lift of more than 140 feet.

A modification of the single-impeller pump is the double-suction volute pump. In this pump the incoming suction column is divided into two separate streams, which enter the impeller on opposite sides, and are discharged into a common vortex chamber. By this arrangement perfect balance is secured. This design automatically balances the thrust, as equivalent operations are performed on both sides of the central plane of the pump. This makes it only necessary to place collars at the ends of the bearing journals, to keep the shaft and impeller in a central position. Such a pump is very satisfactory for heads up to 140 feet and some makers design pumps of this type for even higher lifts. As a general rule, however, for lifts over 140 to 150 feet the best practice is to use two or more impellers in series.

The efficiency of centrifugal pumps based on horsepower input and horsepower output, varies with the size. This is the principal controlling feature. With small pumps, say, 2 inches, the efficiencies obtained are rather unreliable, but a good average is 45 per cent. As the size of the pump increases the efficiency increases until with an 8-inch pump efficiencies from 68 to 70 per cent. are obtained. After this point the efficiency does not increase so rapidly. The best efficiency obtained by Mr. Wiley was from a 24-inch pump built for irrigation service for the United States Government, having a capacity of 13,500 gallons per minute. When operating against a head of 50 feet, at 650 revolutions per minute, this pump showed an efficiency of 83 per cent. About a year after the apparatus had been placed in operation tests were conducted which showed that this efficiency had been maintained, and against the rated head the pump showed an efficiency of 80 per cent. This degree of economy is not obtained in all instances, however, and most guarantees of efficiencies above 80 per cent. are not obtainable commercially except under special conditions.

The next point to be considered briefly is the advantage of centrifugal design over the old reciprocating type. Taking average figures it may be stated that the centrifugal pump costs half as much and weighs one-third as much as a reciprocating pump for the same conditions. For low head work this proportion is greater and in favor of the centrifugal, while for the higher heads the cost of the two types more nearly coincide.

Next is the question of simplicity. Here the centrifugal pump has a marked advantage. There are no valves or springs and only one simple rotating element. The shafting is supported in ring-oiled bearings, cutting down items of attendance. Having about one-third the weight, the ease of erection and transportation is marked. No pump adapts itself to different types of drives with the flexibility of the centrifugal pump. Direct connected, this pump may be driven by electric motor, or by a steam turbine, and for low heads by a steam engine with belt connection, if desired. It is apparent that this flexibility renders the design applicable to any of the various types of prime movers.

One of the latest developments is the steam-turbine driven centrifugal for boiler-feed service. The even flow obtained is distinctly desirable as compared with the intermittent flow obtained from a reciprocating pump. By means of an automatic balanced-throttle valve the speed of the turbine and delivery of the pump can be regulated so as to maintain the water in the boilers at a constant level. The governor on the steam turbine itself can be set so that the turbine cannot operate beyond a certain speed, which speed will limit the pressure generated by the pump itself. This feature renders it impossible to throw dangerous shocks on the pipe line.

The steam-turbine driven boiler-feed pump is not as economical in consumption of steam, in most instances, as the ordinary direct-acting pump, but in many cases the lack of economy is more than counterbalanced by the features above mentioned and the conditions of the installation. In many power stations there is not sufficient exhaust steam to heat the feed-water supply properly, as all the main units are operating condensing. Under these conditions the turbine driving the boiler-feed pump is run noncondensing and the exhaust from the steam turbine is piped to the feed-water heater. By this arrangement the over-all economy obtained is in line with the best practice and the cost of installation, maintenance and attendance is reduced. In both prime mover and pump we revert to the principle of rotary motion with its inherent simplicity.

Briefly the following points should be observed in operating and installing centrifugal pumps. Regardless of the size of suction and discharge on the pump, suction and discharge pipes should be of such size that the maximum velocity of the water will not exceed 200 feet per minute and the use of long-sweep ells is recommended. The pumps should be protected against water hammer on high lift. No centrifugal pump will operate unless fully primed before starting. Unless the suction water flows to the pump under head it is necessary to employ some method to secure a primed condition, as the centrifugal pump will not take up its water under a lift, as in the case of other types, such as plunger pumps. Every centrifugal pump when sold, is sold for a certain duty. If this head or duty is changed the result will usually be a loss of efficiency.

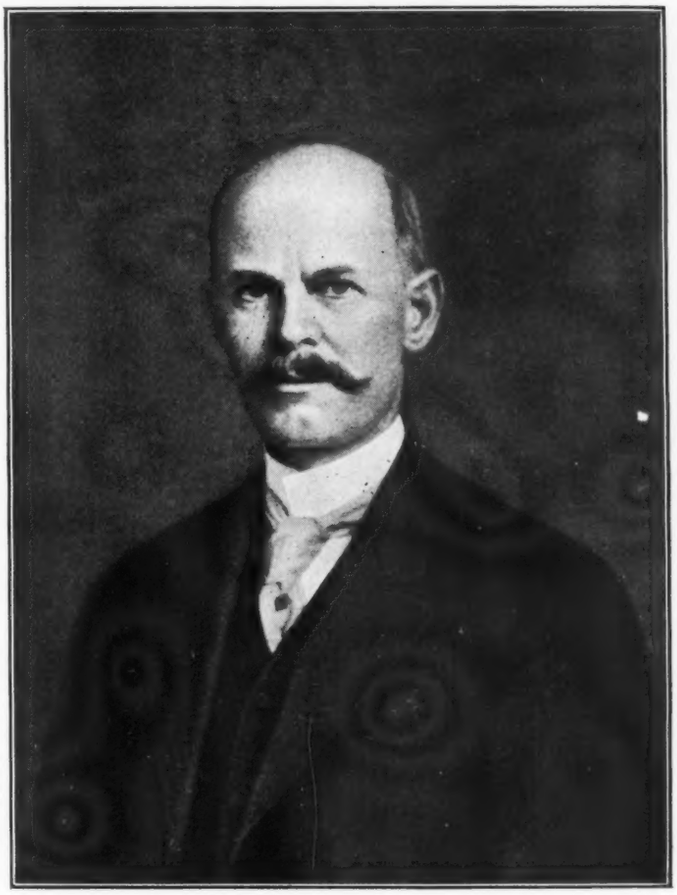
The field of application of the centrifugal pump is limited by practical considerations. This type has been built for a lift of over 1000 feet, but the general opinion is that this construction does not represent the best practice. My personal experience has been that for lifts of over 700 feet a reciprocating pump may be built which will operate more economically and be more durable than a centrifugal pump. In these high-lift centrifugals it is necessary to place a number of impellers in series, say, eight or ten, and the construction becomes bulky and expensive.

Perkin Medal to Edward G. Acheson

On the evening of December 13, the Perkin medal was awarded to Edward Goodrich Acheson. The presentation was made by G. F. Chandler, occupant of the chair of chemistry at Columbia University, who gave a brief history of the decoration, telling how it had been conferred upon William H. Perkin, J. B. Francis Herreshoff and Arno Behr.

Doctor Acheson was born March 9, 1856, at Washington, Penn. At the age of 16 he was taken from school and put at work in his father's blast furnace just above Kittanning. His father dying about this time, he wandered about for a short time, but soon settled at steady work and at 17 produced a drill for the use of coal miners.

This work seems to have led to the development of habits of study, investigation and experimentation, which developed to a marked degree the clear reasoning powers of his mind and the scientific trend of his thoughts. Though early deprived of the benefits of school training, he has always been a student and as such entered the employ of Thomas A. Edison in 1880, and a student he remained during the three years he was associated with the inventor.



EDWARD G. ACHESON

As superintendent of the Consolidated Lamp Company, of Brooklyn, and later as electrician for the Standard Underground Cable Company, of Pittsburg, he was still a student notwithstanding he had already gained an enviable position in the world of science.

In 1891 he discovered carborundum, a crystalline product of the electric furnace, made by fusing together a mixture of coke, salt and sand; a substance harder than all others, except the diamond.

He discovered that clay treated with vegetable extracts would become so finely divided that it would remain indefinitely suspended in water and was also rendered more plastic and much stronger. In fact, he discovered why the Egyptians used straw in making brick.

This discovery was applied to the floating of graphite in water and later in oil, producing two new lubricants, one of which he named Aquadag and the other Oildag, which possess for many purposes advantages over every other form of lubricant known.

Synthetic rubber and upward of 40 other processes and inventions have placed him in the front rank of the world's great scientists. He was honored with the grand prize at the Paris Exposition in 1900, and at the St. Louis exposition in 1904. The American Academy of Arts and Sciences awarded him the Rumford medals, and twice the Franklin Institute, of Philadelphia, gave him the John Scott medal; and on December 13, by the unanimous vote of the joint committees of the Society Chemical Industries, American Chemical Society and the American Electro-Chemical Society, he was presented with the Perkin medal.

"First Loss" in Boiler Insurance

Some of the features of the suit in which the Pabst Brewing Company, of Milwaukee, will seek to recover for damages sustained in the boiler explosion of October 25, 1909, have been made public. Boiler insurance to the amount of $150,000 was carried, but, as previously noted in these columns, the Hartford Company claims that under a clause of the contract it is limited to a payment of $50,000 for damages, which claim is based on the assumption that all three boilers exploded simultaneously, and that virtually there was only one explosion, constituting what is known as a "first loss." The Pabst Company will endeavor to refute this, and claims that there were three separate explosions. In addition to the direct property loss of $114,361.94, which is the sum mentioned in the suit, the Pabst Company will seek to recover a sum of $25,000 for losses sustained while prevented from carrying on its business.

This feature of the suit is probably the first of its kind that has ever been brought to trial in the United States, and will be watched by insurance companies and steam users throughout the country with a great deal of interest. It is alleged that on and prior to September 4, 1909, the insured boilers contained defects which were directly responsible for the catastrophe of October 25, and that they were of such a nature as to be obvious to anyone having the special knowledge and skill in examining boilers as was claimed by the insurance company. It is further alleged that when the Pabst Brewing Company entered into contract with the Hartford Steam Boiler Inspection and Insurance Company, one of the stipulations was that the insurance company should make skilful and careful inspections at such intervals as might be necessary to determine the safety and condition of the boilers, and to report any defects discovered to the Pabst Brewing Company. Under the circumstances, therefore, the latter is seeking to recover not only the property loss but also the business loss entailed while the plant was shut down.

A prize of $5000 has been offered in England for a 24-hour aëroplane motor. In weight the engine must not exceed 245 pounds, and it must develop not less than 35 brake horsepower. The points to be considered in making the award will be weight, fuel consumption, reliability, wear of working parts, etc.

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Filing Current Engineering Literature

Of more than passing interest is the recent discussion in these columns as to the best methods of preserving and making accessible the fragmentary articles on timely topics appearing in current engineering publications. In this issue we present a somewhat exhaustive contribution from an engineer who has evidently given the problem much thought, and who has put the various systems to the test of practical experience.

The modern engineer, whether in the designing office, on the erecting force, or in charge of operation, is necessarily progressive. He must advance. To stand still is to retrograde. The active, studious, and ambitious members of the profession set a stiff pace.

The engineer must mix with his fellows, join the associations and societies of his calling, participate in the reading and discussion of timely papers. He must make the acquaintance of leaders in the profession, for in this way valuable and life-long friendships are established.

In arriving at conclusions his own personal experiences are first in value. Next are the experiences of others. These researches and experiences in time are recorded in textbooks and become authorities of practice.

But engineering today moves too fast for textbooks. Their "lag" is fatal to him who aspires to leadership. So he turns to the modern engineering journal in which is recorded, week by week, the progress of the day—the latest and best. Indeed, as our friend Casey might say, what he finds is "hot stuff—right off the bat."

Knowing where to look for the records, how is he to get the most good from them? How may they be made available when wanted?

In these busy and trying days, no engineer should attempt to retain in his memory more than a few of the more important rules and formulas applying to his own field. His private notebook, kept religiously uptodate, will carry him somewhat further. But the less common applications and the latest advancements, even in his own line, force him back to the printed page. And the broad field of the allied branches of engineering, interesting and valuable as they always are, demands something more than a dependence upon either memory or notebook—something less uncertain and more systematic. We are reminded of the classic remark of the old professor that it was better to know where to find information when needed than to attempt to carry it all in one's head.

Here arises the necessity for some system of filing clippings, or of indexing the articles. For this no general rule can be laid down. It all depends upon the individual, the class of work in which he is interested, the facilities at hand and the time and money he can devote to it. Every man's problem is a special one, and he must work it out alone.

But if he is to be in the running, he cannot afford to neglect this subject, for in it lies the secret of progress. Without it he cannot hope to master his profession.

Can You Beat It?

It is the experience of workers that a monthly wage scale is one of the most difficult things to change. Positions paying by the month in the average corporation are usually the ones upon which the routine operation of the business depends, and are taken as standard, year in and year out, the fluctuations in wages, either up or down, being left to the hourly worker. The mechanical department is usually the one most affected by this monthly wage rule and it frequently develops embarrassing situations, discouraging to the monthly man, making him think that he is wasting his time trying to follow a profession in which his ambition is centered, but which is not receiving its just due in the ordinary commercial disposition of affairs.

An illuminating instance of this is shown in the case of an engineer who, himself working by the month, was surrounded by men working by the hour. This engineer did duty in an important power house, where things had to be kept going night and day, three hundred and sixty-five days in the year, and for his twelve-hour shift received $90 per month.

Working for and under him, was a pipefitter who drew the regular scale of hourly wages for that class of work in this particular locality, whose position, with its eight-hour day and time-and-a-half for Sundays, holidays and overtime, netted him ordinarily $100 per month. In the morning the ninety-dollar-a-month engineer would rise at five a.m., eat a hurried breakfast, hasten over to the power house, and after being on duty

for a half hour, would blow the whistle for his hundred-dollar-a-month assistant to get up. An hour after, he would blow the whistle again for the hourly man to go to work. At noon, while the pipefitter enjoyed a smoke and a comfortable doze in a warm spot alongside the boilers, the engineer adjusted main bearings and connections where the difference of a few thousandths of an inch one way or another meant successful operation or a shutdown, with the responsibility on him; while, after the noon hour, he was privileged to eat his lunch on duty, reading ammeters, dividing up the load and seeing that the machines got into action properly.

In the afternoon he blew the whistle for his eight-hour man to quit work. Then in a couple of hours more he would wend his weary way homeward, passing the cottage where his more fortunate and more highly paid assistant, with his feet elevated on the railing of his front porch, was peacefully smoking an after-supper pipe. Early to bed was the motto, to be ready for the early rising of the next day, while the pipefitter, having plenty of leisure to rest in the early evening, and time to sleep in the morning, would take his wife to a card party, and enter into the social life of the little town, where everybody knew everybody else; yet, although this engineer lived in the town with his family for nearly four years, his wife was commonly supposed to be a widow.

On Sundays, by virtue of the time-and-a-half clause of the hourly man, the difference in the two positions was even more clearly marked, enabling the pipefitter to go to work in the middle of the morning, go home for a couple of hours to a hot Sunday dinner, something the engineer himself enjoyed not oftener than once a year, and still draw a full day's pay. He was frequently required to stand the night watch, and this being all overtime work he drew pay during these periods at the rate of $135 per month, work for which the night engineer was paid $80 per month. He had frequent opportunities to take a regular watch, but scorned the proposition of relinquishing his well paid, short-hour, irresponsible job, for the lower pay, long hours, drudgery and responsibility of the regular runs.

The engineer of this plant was ashamed to figure up what he was making on the basis of an hourly rate and an eight-hour day, lest he could not look his own coal passers in the face; and after years of ambitious study and preparation for the work he took the first opportunity to get out of the operating "game." Do you blame him?

This does not solve the problem for the great mass of operating engineers, with whom it would neither be possible nor advisable to take such action. Custom has so long fixed the pay of engineers that business men do not realize how cheap some of them are working. A company can get an unskilled laborer who perhaps cannot even speak the language of the country, for, say, sixteen cents an hour; or, figuring time and overtime on the same basis upon which the laborer is hired, it can get for twenty cents an hour a skilled engineer, one who has devoted his life to the work, to take the operating responsibilities of a quarter of a million dollar power house, which was the value of the one in the above instance.

It is neither logical nor businesslike to expect this from engineers, and a campaign of education among employers, backed up by proper license laws, should and must better conditions if we are to expect the best men to stay in the operating field.

Gas Power and the Steam Engineer

The great majority of our readers have a direct and vital interest in matters pertaining to steam and steam-electric plants, but information from the newer field of gas-power engineering must perhaps meet some mental inertia in seeking attention. This puts us on our mettle to make the new Gas Power Department interesting even to those who may regard it as more or less of a side issue; and yet there are practical reasons why this department should appeal to the steam engineer.

Only the rank enthusiast will predict an early displacement of the steam engine by the gas engine; but it is entirely safe to say that in the coming years the rate of increase in the equipment in use —that is, the proportion of new installations—will be far greater for the gas producer and engine than for the boiler and steam engine. This will mean an increasing demand for men to operate the new type of plant, and many of these men will be recruited from the ranks of the steam engineers, especially of the younger generation.

It may be a sign of conservatism, but the idea persists that the gas engine, in its operative process, is more complicated and more sensitive than the steam engine. That is, it is more liable to derangement, and the disorder is likely to be more serious. A steam plant may be working badly and wastefully, and yet be kept going and made to deliver power; with an equal disarrangement in its functions, the gas engine may refuse to run at all.

The steam plant generates its energy in the furnace, puts it into the working medium in the boiler, and keeps a lot of it stored there ready for use; the engine has merely to apply this energy as the load requires. The gas engine concentrates within its cylinder the whole operation of generating and applying energy, and naturally is more liable to disabling disorder—with the additional trouble that the output of the producer is not the same uniform substance as that of the boiler. It is probably a fair statement to say that the degree of care and skill needed to maintain really good working is about the same for both types of plant, but that the gas plant feels the lack of such care sooner and more seriously than does the steam plant.

That the internal-combustion engine has presented a much more difficult problem than the steam engine is clearly indicated by its far slower development; but modern skill and science, impelled by the economic pressure of high cost of fuel (especially in Europe), have solved the problem. The economic advantage is on the side of the gas-power plant, and will grow as the vexatious minor difficulties are more surely overcome with fuller experience.

The man who is called on to operate a new machine will get along much better if he has a thorough understanding of the principles on which the machine works. He may simply follow directions, moving certain handles or opening certain valves in order to get a desired result. But suppose the result fails to come as expected; if he knows the how and the why of proper operation he can make an intelligent search for trouble instead of being thrown into hopeless bewilderment.

The way to learn how to run a machine is, undoubtedly, to run it; nevertheless, the process of acquiring skill will be greatly helped by a thorough descriptive knowledge and by learning beforehand the experiences of others. On more grounds than the desire for knowledge and the propriety of keeping an open mind, the progressive steam engineer will do well to learn all he can, by reading and by observation where possible, about the latest kind of power-plant machinery.

The remarkable similarity of the failures in the six drums of the water-tube boilers which exploded at Pabst brewery, Milwaukee, has been noted in these columns with the suggestion that the idea of the reinforcing strip, as applied, was fundamentally wrong. It now develops on careful examination that the two remaining boilers of the same type which escaped destruction at the time, both have the sheets cracked between the rivet holes along the reinforcing seam, at the point where all the other drums let go.

It is reported that the large Redondo plant of the Pacific Light and Power Company is to be remodeled and low-pressure turbines are to be installed.

NEW·POWER·HOUSE·EQUIPMENT

What the Inventor and the Manufacturer are doing to save time and money in the Engine room and Power house

A Small Gas Engine on Large Lines

By Osborn Monnett.

The familiar type of single-cylinder horizontal single-acting gas engine has been to a large degree the result of growth and experience in the design of engines of small capacity, the constructional details being merely enlarged, as circumstances warranted. Engines of this type that have been thus developed from small sizes naturally embody weaknesses that tend to prevent their successful application, especially with producer gas, when long hard service is demanded. In this type of engine it is difficult to get good regulation without flywheels of excessive weight, hard to get exhaust valves to stand the temperatures of continued service, and there are little troubles with valves, igniters, bearings, and the small side chamber which has been part of the design of most small gas and gasolene engines. On the other hand, it is undeniable that in most cases large engines, say from 100 horsepower upward, are the results of better engineering, study and practice; that the manufacturers regard their design and construction in a more serious light, as there are involved greater risks and the operating requirements are more severe.

Realizing these facts and the importance of them, the line of small engines illustrated herewith has been brought out by the Elyria (Ohio) Gas Power Company with a full appreciation of what the limitations of the small gas engine here-

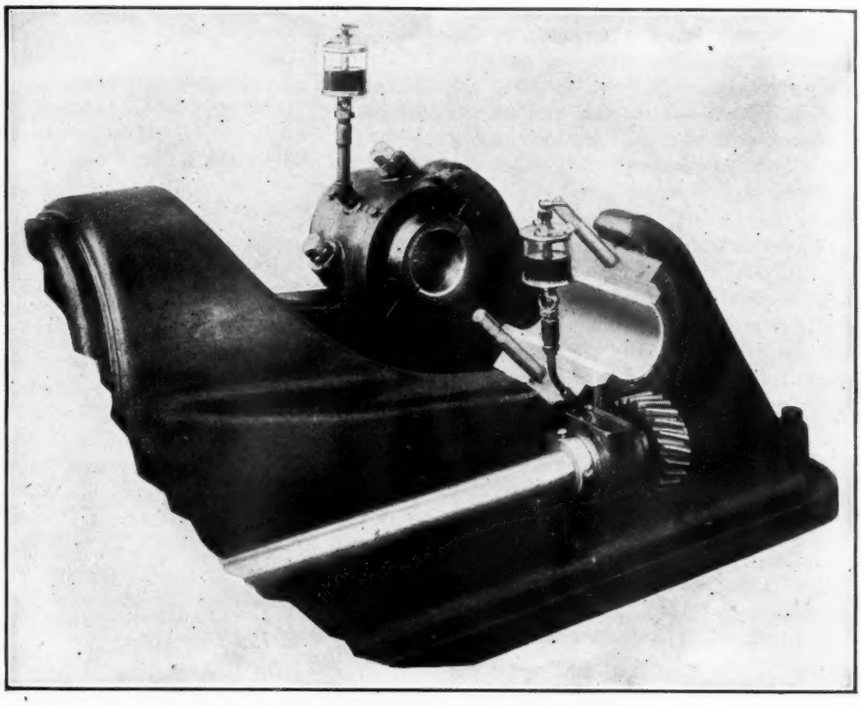


Fig. 2. Main Frame and Journal Boxes

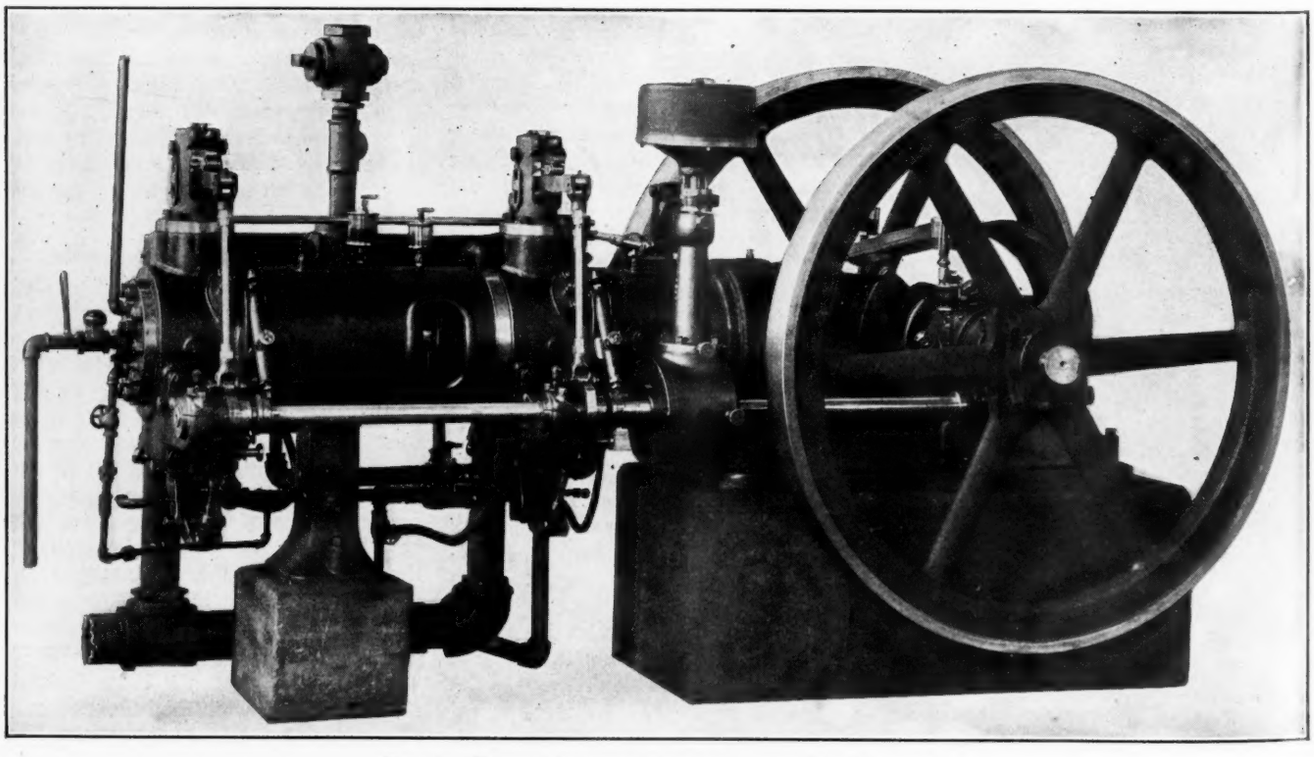


Fig. 1. Elyria Tandem Single-acting Gas Engine

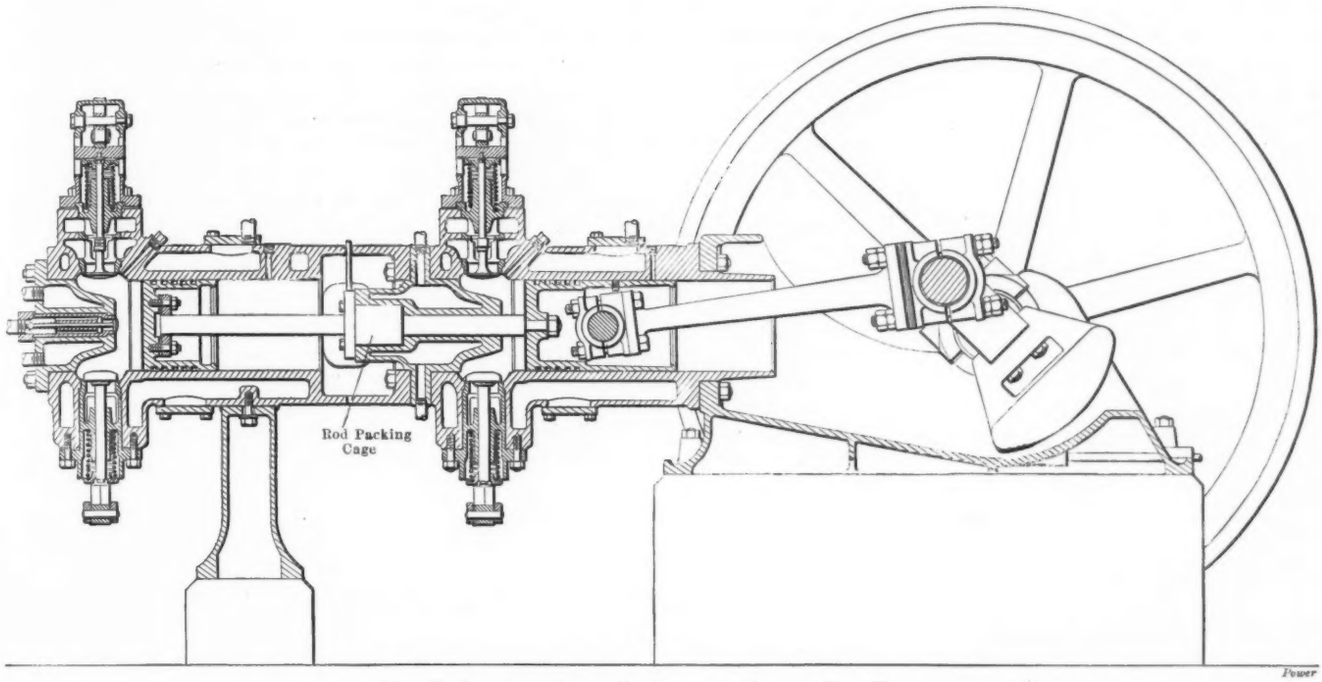


FIG. 3. LONGITUDINAL SECTION OF ELYRIA GAS ENGINE

tefore have been, and a desire to apply the same principles and practice which have been developed in large engine construction to the smaller sizes, and thereby put the small-engine business, especially within the range of 10 to 75 horsepower, on a better footing.

It will be seen from the illustrations that many of the characteristics of much larger engines have been embodied in this line, especially as to valve gear and the method of governing. The engines are of the horizontal single-acting tandem type, working on the four-stroke cycle. The frame is made up of heavy box section walls, carrying main bearings split at an angle of 45 degrees. The engine is of the center-crank type, and two bearings are used in order to avoid, as far as possible, crank-shaft troubles, which are liable to occur when more than two bearings have to be kept in line. The bearings themselves consist of cast-iron sleeves machined to fit the bed and caps. They are lined with nickel bronze babbitt, and may be removed by raising the shaft slightly.

The rear cylinder rests on a pedestal, as shown in Fig. 1, with provision for expansion, and has a flanged extension by which it is bolted to the forward cylinder, as illustrated in Fig. 2, bringing all stresses in a direct line. The water-jacket spaces are large and are provided with

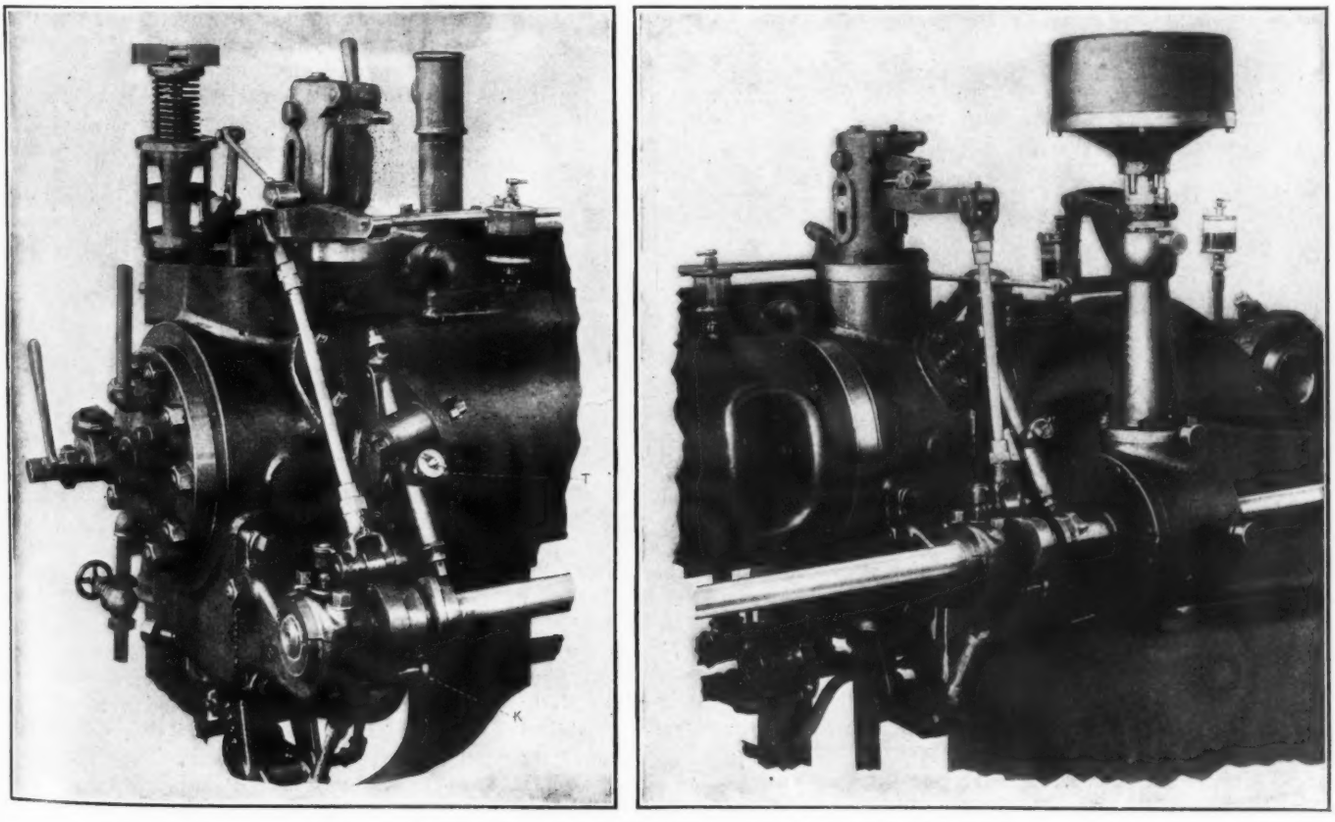


FIG. 4. VALVE GEAR AND GOVERNOR OF THE ELYRIA GAS ENGINE

handholes at the top and bottom; the barrel jackets are stopped off at each end of the cylinder castings so that no water joint is made between the cylinder and head jackets. Marine-type boxes are

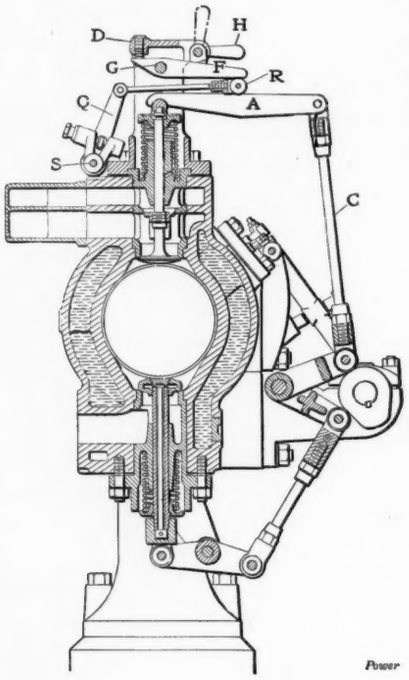


FIG. 5. VALVE GEAR DETAILS

used at both ends of the connecting rod, only metal liners being used to make adjustments of both pins and boxes.

As shown in the sectional view, Fig. 2, the rod packing cage is held in the head of the forward cylinder and liberally water jacketed. A split cast-iron case

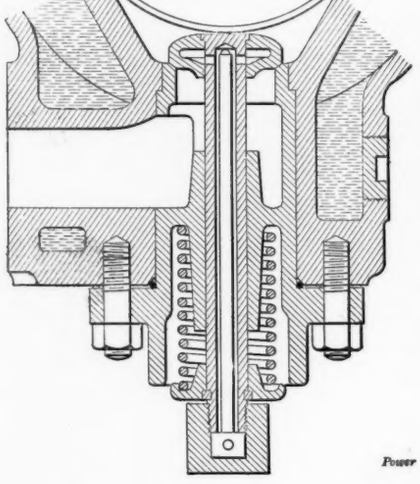
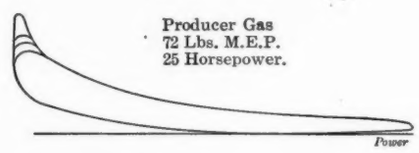


FIG. 6. ELYRIA EXHAUST VALVE

holds the sectional rings of packing in place, and this can be detached and removed through the hand-holes in the side of the extension of the rear cylinder.

All of the inlet and exhaust vales are in cages. The inlet and exhaust valves of each cylinder are mechanically operated through a single cast-steel cam as shown in Figs. 4 and 5, and open directly into the combustion chamber, the inlet on top and the exhaust on the bottom. The inlet valve and stem is a steel forging. The exhaust valve, shown in Fig. 6, is hollow with a cast-iron head shrunk to a hollow steel stem, and a brass tube inserted to effect circulation of cooling water; the valve-cage housing itself is water jacketed.

Another feature common to big-engine practice is to be found in the method of fuel mixture. Air and gas are brought in separate passages to the inlet valve through a manifold above the cylinders, as shown in Fig. 5. The inlet-valve stem carries the main inlet valve and, higher up on the stem, another valve which controls the opening of the gas passage. The air and gas are therefore kept separate until just before they enter the cylinder, and there is no mixture likely to collect in the manifold back of the inlet valve. The governor is of the high-speed centrifugal type, driven by a



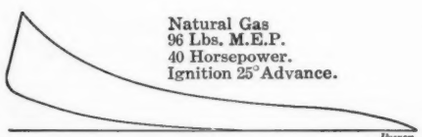


FIG. 7. DIAGRAMS FROM ELYRIA GAS ENGINE

cast-iron beveled gear on the side shaft and a steel pinion on the governor spindle. The method of governing is that known as "constant quality, variable quantity," and is effected through the movement of rollers changing the fulcrum point of the inlet valve rocker arms and thereby varying the lift of the inlet valves. Fig. 5 shows the complete valve-gear of one cylinder. The push rod *C* raises the end of a rocker-arm *A* for which the roller *R* forms a movable fulcrum. The upward thrust of the arm *A* against the roller is taken immediately by a finger *F* pivoted at *G* and backed up by a cam on the handle *H;* this cam takes the pressure finally. With the handle in the position shown by the solid lines, the arm *A* rocks against the roller *R* and opens the inlet valve. The extent of the opening is determined by the position of the fulcrum roller *R*, which is controlled by the governor through the shaft *S*, the arm *Q* and the horizontal link carrying the roller *R* at its free end.

Adjustment of the "stroke" of the inlet valve for the normal load position of the roller *R* is made by means of an eccentric pivot pin *G* and right-and-left threads on the ends of the push rod *C*. A cylinder can be cut out of operation by raising the handle *H* to the position shown in dotted lines. This turns the buffer cam away from the finger *F*, and a spring *D* raises the long end of the finger away from the roller *R*. The upward motion of the rocker arm *A* then merely lifts the roller *R*, using the end of the valve stem as a fulcrum; consequently the inlet valve remains closed and the cylinder receives no charge. By pulling out the knob *K*, Fig. 4, the exhaust push-rod roller engages a relief cam which opens the exhaust valve during the suction stroke and prevents the back pressure which would otherwise exist because of the partial vacuum formed in the cylinder. These two simple movements put the cylinder entirely out of service, enabling the attendant to remove an igniter or make minor repairs without shutting down the engine.

Mechanical make-and-break ignition is used, the igniter trip being operated by means of a drop-off cam. Timing of the ignition through any desired range is accomplished by screwing up or down the nurled knob *T*, Fig. 4, while the trip plunger is held out against this knob by a spring. Should the engine turn backward the trip plunger would simply press back against the spring until it cleared the cam. It is therefore not necessary to fasten the igniter cam to the shaft by means of a clutch, as is common practice; instead, a small piece of steel bolted to the side of the relief cam is used, and in case of wear it can be removed easily at slight expense.

Indicator cards taken from an 8½ by 12-inch tandem engine, running at 325 revolutions per minute on natural gas and also on producer gas, are shown in Fig. 7.

This engine, because of the many features usually found on large engines only, has been called the "Little Big Engine,"

Diaphragm Draft Gage

This instrument is fitted in a 6-inch case and is similar in appearance to the ordinary steam-pressure gage, as shown in Fig. 1. The mechanism consists essentially of the specially designed double-diaphragm spring, connected to a movement which transmits any action of the diaphragm to the pointer. Referring to Fig. 2 it will be seen that a small rod is fitted to the frame section. This rod receives a semi-rotary motion by means of a bent pin (not shown), one end of which is flattened and forms a sliding contact on the top side of the diaphragm as it moves in or out. The rod, in turning, imparts motion to the sector by means of a pin fitting in the slots, as shown, the sector moving the pointer by means of a pinion on the

pointer shaft. The entire apparatus is dust, as well as water proof.

The connection to the instrument is made by a ½-inch pipe leading to the point where readings of the draft are to be taken, and the indications on the gage

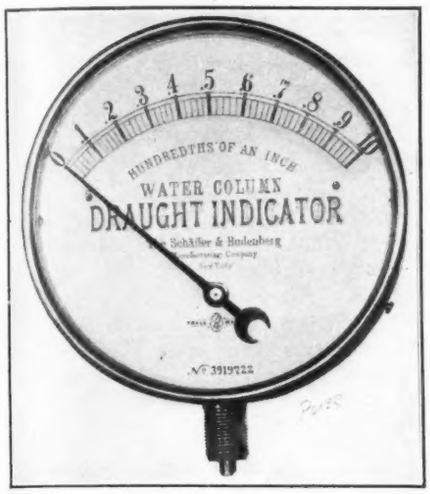


FIG. 1. DIAPHRAGM DRAFT GAGE

are produced in exactly the same way as in any ordinary draft gage. With this instrument, observations of the draft can be made as readily as that of the steam pressure, consequently proper attention to the draft can be given, and the large dial enables easy readings of 0.01 inch of water column.

To enable the engineer or fireman to immediately notice whether the draft is right, the instrument may be fitted with a red pointer adjustable from the outside of the gage, the pointer being set after

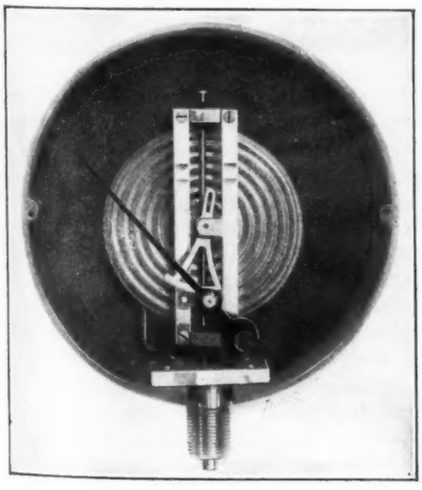


FIG. 2. INTERIOR VIEW OF DRAFT GAGE

the most favorable draft conditions have been ascertained.

The instrument is also made in the recording type, giving a daily record, thus showing if proper draft conditions have been maintained.

The special double diaphragm with which both types are fitted is very sensitive and of such power as to reduce any error due to friction to a minimum. It is claimed that this error has been proven by test to be less than that caused by capillary attraction and evaporation in the glass-tube instruments.

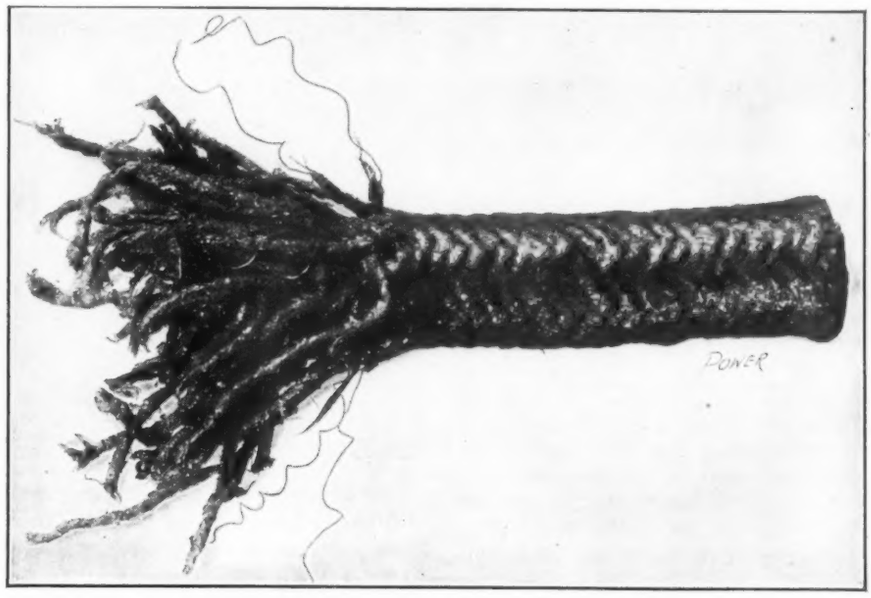
By connecting the indicating draft gage by a three-way cock or several cocks to various pipes, readings of the draft of various furnaces can be had.

This instrument is manufactured by the Schaeffer & Budenberg Manufacturing Company, 963-5 Kent avenue, Brooklyn, N. Y.

High Pressure Packing

It is pretty generally conceded that asbestos is the only fiber capable of withstanding a high temperature; consequently, for rod-packing purposes, where a high pressure of steam is carried, that material is used in several forms, generally made up of twisted asbestos cord, saturated with lubricants, and firmly braided together into different sizes. By this means a well lubricated, heat-resisting packing is secured. Even in this form it is not entirely satisfactory, because the fiber being short, there is the danger that it will pull apart while in use and cause a bad leak which would soon require removal.

To guard against such weak spots the

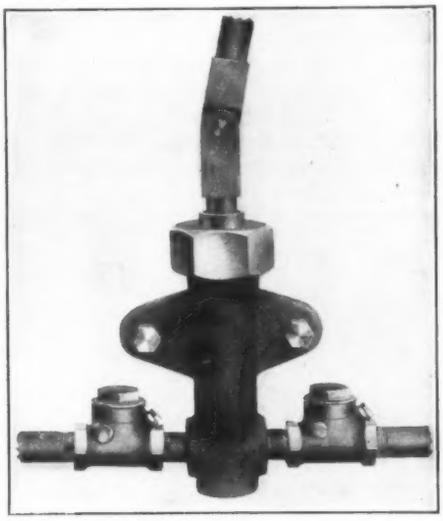


ASBESTOS CORD WOUND WITH ANTIFRICTION WIRE

Eureka Packing Company, 78-80 Murray street, New York City, reinforces the asbestos cord with an antifriction wire wound around the strands, which not only holds the fiber together, but adds strength to the entire cord. This wire winding is shown in the accompanying illustration. It is claimed that in this form, every essential feature in a packing is secured.

Richardson Oil Plunger Pump

The design of pump shown herewith is for use in connection with oiling systems where a simple, durable pump is required to handle the dirty oil that



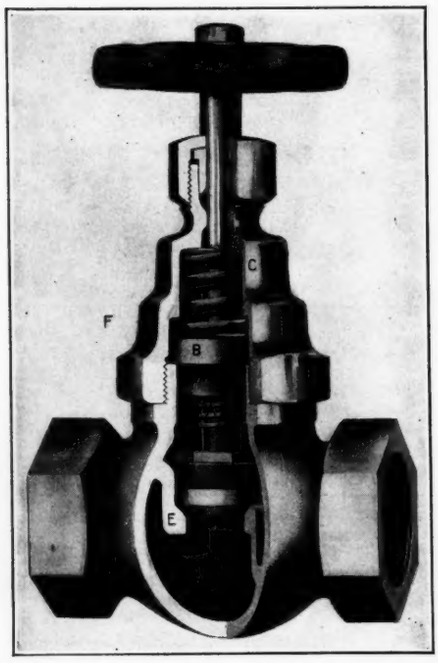
RICHARDSON OIL PLUNGER PUMP

drains away from the engine bed, and return it to the filter, or take oil from a filter and elevate it to an overhead storage reservoir. High-grade check valves are used, which are easily accesible for cleaning. This pump, it is claimed, requires no attention when once installed and is foolproof. It is manufactured by the Sight Feed Oil Pump Company, Milwaukee, Wis.

The Swenson Self-grinding Valve

The accompanying illustration shows a semi-cross-section of the Swenson self-grinding globe valve, which is constructed on a new principle, with the result that every time the valve is opened or closed a slight grinding takes place between the disk and seat, insuring a tight contact between these two parts.

The threads *A* on the valve stem engage with threads in the movable nut *B*, which, by the turning of the stem, is moved up and down in the small chamber *F* in the bonnet; this nut *B* is kept from turning by engaging with a lug on each side. The coiled spring *C*, placed just above the movable nut *B*, presses against it with sufficient force



INTERIOR VIEW OF VALVE

to hold it against the lower shoulder of the chamber *F*, until the disk *D* begins to seat. Any additional movement of the handwheel in the same direction turns and grinds the disk *D* on the seat *E*, at the same time forcing the movable nut *B*, upward, which increases the tension on the spring *C*, and consequently the pressure of the disk against the seat. The operation is complete when the movable nut comes to a stop against the shoulder at the top of the chamber *F*, where the nut *B* virtually becomes a part of the bonnet.

In opening the valve the operation is reversed, for as the handwheel is turned, the disk *D* turns and grinds on its seat; the movable nut *B* travels downward, and the tension of the spring *C* decreases until the nut reaches the lower shoulder of the chamber *F*, and virtually becomes a part of the bonnet at this point.

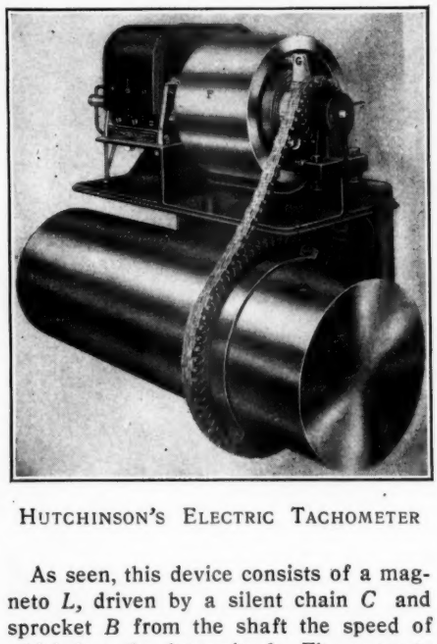
The valve is so designed in the relation between the movable nut *B* and its chamber *F*, that the nut travels the distance between the upper and lower shoulders of this chamber in about one turn of the handwheel, during which time the disk and seat are in grinding contact. It is claimed therefore, that scale, dirt or other sediment gathered on the seat is ground to powder and thrown out by the grinding motion, thus producing a perfect contact between the disk and seat.

If for any reason it becomes necessary to regrind the valve, the handwheel, movable nut and spring are removed, the bonnet is replaced and the valve can be reground the same as any other valve. The valve disk is of heavy construction and will permit of many grindings before having to be renewed. It is loose on the stem to a sufficient extent to enable it to aline itself with the seat at whatever angle the valve is installed. The packing nut is furnished with a gland, and the bonnet has a ground joint seat.

This valve is manufactured by the Valve Sales Company, La Crosse, Wis.

Hutchinson's Electrical Tachometer

To provide a sensitive and yet non-vibrating tachometer that may accurately indicate at a distance, as, for instance, in the superintendent's office, just how fast the machinery of a factory or shop is running, has led to the development of the Hutchinson electrical tachometer, illustrated herewith.



HUTCHINSON'S ELECTRIC TACHOMETER

As seen, this device consists of a magneto *L*, driven by a silent chain *C* and sprocket *B* from the shaft the speed of which is to be determined. The magneto is of the automobile type, that is, with stationary permanent field magnet and a stationary armature coil, between which soft-iron inductor pieces rotate, generating an alternating current. The voltage generated is directly proportional to the speed of rotation, and this is read on a special voltmeter calibrated directly in revolutions per minute of the shaft. The use of alternating current does away with all commutators and brush contacts which have hitherto caused uncertainties in the readings of electrical tachometers.

For marine use, which is one of its broadest fields, twin magnetos driven at the same speed furnish two currents; one from one side to the moving coil of the indicator and one from the other side to the stationary coil. For rotation "ahead" these alternating currents are in electrical phase and the reading is on the "ahead" side of the scale. For reverse or "astern" rotation, one magneto rotor slips back 90 degrees, throwing the alternating-current impulses from the two magnetos out of phase by 180 degrees. This reverses the motion of the indicating hand so that it reads on the other end of the scale, thus showing reversed rotation as well as revolutions per minute.

By interposing the small, but heavy flywheel *F* on the magneto shaft and driving through two oppositely coiled flat springs *E*, instantaneous variations in angular velocity of the engine shaft during a single revolution are smoothed out so that the indicating hand does not vibrate. The arm *G* is for the purpose of protecting the spring against breaking due to reversing the direction of rotation.

Another advantage of this device is that as many voltmeter speed indicators may be installed as desired, so that the information may be before as many men in as many different places as necessary. It is manufactured by the Industrial Instrument Company, Foxboro, Mass.

The government of Denmark proposes to carry out with the aid of its engineers the following plan: Upon the southern shore of the Sund is found the old city of Helsingborg, not far from which the Lagu rushes down from an elevated plateau over a stretch of about 30 kilometers. A fall of 100 meters is situated not more than 2 kilometers from the mouth of the Lagu. It is at this point and for the purpose of using this important natural motive force, that it has been decided to establish a hydro-electric plant, transmitting its current to Helsingborg (first relay). The submarine cables traversing the Sund permit the distribution of the electric energy produced in Sweden over the territory of Denmark. The island of Seland, in which is found the Danish capital, will be the first to benefit by this installation, which will be very easily carried out; for between Helsingborg (Sweden) and Helsingör (Denmark) the arm of the sea is very narrow, not more than 5 kilometers wide; due to this circumstance the work necessary for the establishment of the submarine cables does not present any insurmountable difficulties.

INQUIRIES OF GENERAL INTEREST

Questions are not answered unless they are accompanied by the name and address of the inquirer

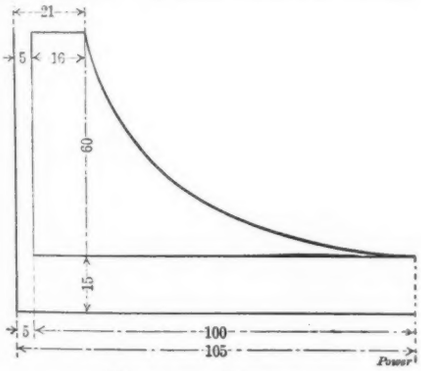
Point of Cutoff

If steam is at 60 pounds gage, clearance 5 per cent., what should be the point of cutoff to have the terminal pressure at atmosphere?

F. S. J.

Sixty pounds gage pressure is, in round numbers, 75 pounds absolute and atmospheric pressure is 15 pounds absolute. Dividing the initial pressure by the terminal gives 5 as the number of expansions necessary to expand steam of 60 pounds gage pressure to that of the atmosphere, and in a cylinder without clearance the cutoff would take place at one-fifth of the stroke.

But as there is a clearance of 5 per cent. of the piston displacement the cylinder volume is greater than the volume



POINT OF CUTOFF

swept through by the piston and if the cutoff took place at one-fifth of the piston stroke the number of expansions would be less than five and the terminal pressure would be above the atmosphere, and the cutoff must be shortened to such a point in the piston travel that the volume of piston displacement plus 5 per cent. will be just five times the clearance plus the piston displacement at cutoff.

Now let the piston displacement be imagined as being 100 volumes, then the entire number of volumes in the cylinder at the end of the piston stroke including clearance would be 105.

The space occupied before expansion was one-fifth of 105, or 21 volumes, but as five of these volumes were included in the clearance there would be 16 volumes in the travel of the piston up to cutoff, so that in order to expand steam of 60 pounds gage pressure to atmospheric pressure in a cylinder having 5 per cent. clearance the cutoff must occur at 0.16 of the piston travel.

In the accompanying diagram let the distance marked 100 represent the volume of one stroke of the piston. As the clearance is stated as 5 per cent. of the cylinder volume, this can be represented by an addition to the length of the cylinder at the head end, such that its volume will be equal to 5. Then as seen by the diagram, the total volume of the cylinder, plus the clearance, will be 105. Now the conditions of the problem are that the steam shall be expanded from 75 pounds absolute down to atmosphere, or that there shall be five expansions. This means that the final volume of the steam shall be five times the original volume. As the total volume is 105, one-fifth of this will be 21.

In the setting of the valves the point of cutoff is measured in percentage of the stroke, and this percentage does not include the clearance volume. When the piston has moved through a distance such that the total volume of the steam in the cylinder shall be 21, it is clear that, as the clearance volume is represented by 5, the remainder of the volume must be equal to 16.

As the volume swept through by the piston is directly proportional to the travel of the piston, the total travel may be assumed as 100. Therefore at the point of cutoff when the piston has moved through 16 volumes its linear travel may be represented by 16. The cutoff, being the ratio of the travel of the piston up to the point of closure of the steam valve, to the total stroke, will be 0.16 or 16 per cent. of the stroke.

Useful Boiler-room Rules

Will you please give me a rule for finding the diameter of the water and steam end of a boiler-feed pump, a rule for finding the efficiency of a triple-riveted joint and a rule for finding what stress diagonal stays are good for.

M. J. A.

To find the capacity of a pump to feed a boiler it is necessary to know how much water will be evaporated per hour. It is good practice to operate a pump slowly and for this reason the pump running at its normal speed should be capable of supplying considerably more water than the boiler evaporates under ordinary conditions. To find the diameter of a water cylinder to deliver a certain number of gallons of water per hour, the stroke of the piston and the number of strokes per minute must be assumed. Then, multiply the number of gallons by 231 to get the number of cubic inches and divide the product by the stroke of the piston and divide this quotient by the number of strokes per minute, and multiply the last quotient by 0.7854. Then, extract the square root of the result and it will give you the diameter of the water piston.

There is no cast-iron rule for the proportion of the water piston to the steam piston, but the steam piston is usually made approximately one and one-half times the diameter of the water piston.

The strength of a properly designed, triple-riveted seam is the strength of the plate through the outer row of rivets and is usually expressed as the efficiency of the joint. It is found by subtracting the diameter of the rivet hole from the pitch of the rivets and dividing the remainder by the pitch. Expressed as a formula it reads:

$$\frac{P - d}{P} = \textit{Efficiency of joint.}$$

Boiler stays should not be subjected to a stress greater than 6000 pounds per square inch of cross-sectional area. Find the area in square inches that is supported by the stay. Multiply this by the pressure in pounds per square inch. Multiply this product by the length of the diagonal stay. Divide the result by the perpendicular distance from the flat surface to the end of the stay. This will give you the stress on the stay. This divided by 6000 will give you the number of square inches necessary in the cross-sectional area.

Standard Table for Taper Fits

Is there any standard table for taper fits such as used on piston rods and crossheads?

A. B. D.

There is no standard. Each builder selects that taper which he considers best adapted to the conditions under which it is to be used.

Wrought-iron Crank Shafts

Why do some engine builders prefer wrought iron instead of steel crank shafts?

C. A. D.

It is claimed that iron is more homogeneous and less liable to crystallize than steel.

Cutting Oil Cup Glasses

How can I cut oil-cup glasses which are 3 inches in diameter?

C. D. C.

They may be cut with a diamond or with a steel wheel cutter. After cutting, the surfaces must be made true by grinding.

NEW PUBLICATIONS

FOWLER'S MECHANICAL ENGINEER'S POCKETBOOK. D. Van Nostrand Company, New York. Leather or cloth; 650 pages, 4x6 inches; numerous illustrations and tables. Price, 50 cents in cloth; 75 cents in leather.

This is the twelfth annual edition of Mr. Fowler's useful little book, and notwithstanding its age and previous merit, he has found occasion to revise it again. The sections devoted to mining machinery and metallurgy have been largely rewritten and somewhat enlarged, especially with respect to developments in steel alloys. The section relating to chemistry is rather skimpy, but this will doubtless be expanded in future editions.

FOWLER'S ELECTRICAL ENGINEER'S POCKETBOOK. D. Van Nostrand Company, New York. Leather or cloth; 560 pages, 4x6 inches; numerous illustrations and tables. Price, 50 cents in cloth, 75 cents in leather.

This, the companion to the mechanical pocketbook mentioned above, does not show as much evidence of recent revision as its mate, and it is deficient in illustrations. The brief description of magnetic testing apparatus, for example, would have been much more lucid if illustrations of the apparatus had been presented. The extended description of the Edison storage battery, taken from Doctor Kennelly's paper of 1901, does not add to the practical value of the book, the battery having been obsolete for more than five years.

The dynamo and motor sections are rather better than the others and contain a great deal of useful data, but the book suffers throughout from the policy of presenting too few fundamental principles in unnecessary detail and with too few diagrams.

ELEMENTS OF MACHINE DESIGN. By W. Cawthorne Unwin, F. R. S. Published by Longmans, Green & Co., New York, 1909. Cloth; 545 pages, 5½x8½ inches; 387 illustrations. Price, $2.50.

Professor Unwin's "Machine Design" has been the principal engineering reference book on its subject for more than thirty years and so fundamental in character that but little revision has been necessary. The author, however, decided last year that the usual method of revision "in spots" was not adequate in view of the great advances and developments in mechanical engineering during the past few years; consequently, he has rewritten all of the book except the parts devoted to absolute fundamentals, which never change. He has retained the admirable plan of presenting propositions, theorems and their applications in practical form for ready use, which contributed in no small degree to the widespread appreciation and adoption of the original book. Chapter VIII, on axles and shafts, is a conspicuous example of this common-sense method.

Chapter II, on straining actions, has been considerably expanded, notably by the addition of the results of recent experiments on reversing stresses, made by Doctor Stanton at the National Physical Laboratory. The chapter on journals, crank pins, etc., contains much valuable new matter relating to lubrication. Chapter X, on bearings for shafts, has been enhanced in usefulness by a concise, masterly discussion of ball bearings in which the twisting motion of the balls in improperly designed races is pointed out, and the conditions for proper operation explained. To the chapter on chain drive the author has added an exposition of the Renold silent chain which presents the only complete and correct analysis that the reviewer has ever seen.

With respect to such a classic one hesitates even to hint of deficiencies, but entire candor prompts the suggestion that a complete list of symbols at the beginning or end of the book would greatly facilitate its use in everyday engineering practice.

"The Occluded Gases in Coal," by S. W. Parr and Perry Barker, issued as Bulletin 32 of the Engineering Experiment Station of the University of Illinois, is essentially a study of the behavior of coal toward the atmosphere. The avidity of coal for oxygen is made evident, and the results of the entire work bear directly upon the matter of weathering and of spontaneous combustion. Copies of bulletin No. 32 may be obtained gratis upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Reorganization of Chicago Engineers Examining Board

Following the charges of irregularities in the board of examining engineers of the city of Chicago some time ago, Mayor Busse announced his intention of completely reorganizing this department with the object of bringing it more closely under the control of the city administration. The work of examining and licensing engineers has since been placed under the jurisdiction of the city engineering department, with City Engineer John Ericson as president, William J. Burns, vice-president and J. J. Hoolihan, secretary.

The members serve on the board in addition to their regular duties in the city engineering department, and without additional compensation, while four license inspectors, who visit engine rooms for the purpose of determining whether licenses are properly applied, are civil-service appointees.

In drawing up the new rules under which engineers are examined, President Ericson called a conference of representatives of all the various engineers' organizations and prominent operating engineers to discuss the different measures, to the end that all possibility of irregularity in their enforcement should be eliminated.

One of the clauses in the new rules requires that an engineer on renewing his license must send a written order or come in person to the office of the board, and sign a receipt which can be compared with the original signature on the application. This precaution is taken to guard against unauthorized persons using licenses of men who have died or moved away since the permit was issued. In every possible manner the effort is being made to conduct the department on a strictly fair and square basis.

The issuing of a license is not based entirely upon the result of a written examination. After passing this test an applicant must appear before one of the members of the board and be examined as to age and physical ability, intelligence and education, experience, and also must pass an oral examination on engineering subjects, each point being weighed in making a final decision as to the granting of a license.

PERSONAL

Edward B. Richardson, formerly assistant engineer with Hollis French & Allen Hubbard, and Richard K. Hale, formerly assistant engineer with Robert Spurr Weston and Messrs. Metcalf and Eddy, have formed a partnership under the firm name of Richardson & Hale, 85 Water street, Boston, Mass. The new firm will do a consulting business in the mechanical, electrical, hydraulic and sanitary fields.

F. A. Hall has resigned his position as manager of the chain block and hoist department of the Yale & Towne Manufacturing Company and has been made vice-president of the Cameron Engineering Company, 150 Berriman street, Brooklyn, N. Y. The latter company controls a number of patents relating to overhead transportation and conveying, covering hangers, switches, turntables and ball-bearing trolleys, and has been in existence about twelve years, during which time it has developed devices for overhead transportation to a point where it is now possible for such transportation to be standardized in much the same manner as transmission equipment is regulated. In his new connection, Mr. Hall will utilize the Yale & Towne blocks and hoists in his work. He will be succeeded by R. T. Hodgkins.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

BOILERS AND FURNACES

TOP FOR FURNACES. Frederick C. Stimmel, Chattanooga, Tenn. 944,296.

REGENERATIVE FURNACE. Emil Kirchberg, Dortmund, Germany. 944,444.

AUTOMATIC STOKER. John M. Fleming, Ottawa, Ontario, Canada. 944,778.

MECHANICAL STOKER. Peter J. Harleman, Boston, Mass. 944,551.

CHAIN-GRATE FURNACE. Leroy H. Maxfield, Godfrey, Ill. 944,454.

FURNACE. Harry P. Bobbitt, Los Angeles, Cal. 944,591.

STEAM BOILER. Ellis F. Edgar, Woodbridge, N. J. 944,669.

BRIDGEWALL FOR FURNACES. George Warrington, Washington, D. C., and Luther D. Lovekin, Philadelphia, Penn. 944,753.

HOT-WATER AND STEAM BOILER. Harry L. Worden and Henry O. Wurmser, Lorain, Ohio. 944,759.

FUEL FEEDING and Regulating Apparatus. John Hutchings, London, England. 944,868.

SMOKE CONSUMER. William Acheson, Pittsburg, Penn. 944,933.

OIL BURNER. Curtis C. Lillibridge, Shattuck, Okla. 944,886.

PIPE JOINTS, COUPLINGS AND TOOLS

WRENCH. Reuben Miller, Jr., Pittsburg, Penn. 944,270.

WRENCH. William O. Stanley, Alliance, Ohio. 944,468.

EXPANSION JOINT for Pipe Lines. Eugene F. Osborne, Chicago, Ill. 944,273.

PIPE JOINT. Claude Revaillot, Nice, France. 944,503.

ADJUSTABLE SUPPORTING DEVICE for Pipes. Egbert H. Gold, Chicago, Ill. 944,731.

COUPLING. Ernest A. Koschinski, Scranton, Penn. 944,877.

PIPE-REAMER ATTACHMENT for Threaders. George Reed, Pittsburg, Penn. 944,909.

VALVES

VALVE (STOP). Charles W. Sherburne, Boston, Mass. 944,286.

STEAM SAFETY VALVE. Milton A. Hudson, Philadelphia, Penn. 944,330.

NONRETURN VALVE. Edward V. Anderson, Monessen, Penn. 944,402.

VALVE-OPERATING FLOAT. William Briggs, Brooklyn, N. Y. 944,477.

REDUCING VALVE. Fred M. Carroll, New Haven, Con. 944,664.

STEAM AND LIQUID PRESSURE Regulating Device. Charles P. McMullen, New York, N. Y. 944,689.

SAFETY VALVE. Harry C. McCarty, Williamsport, Penn. 944,809.

VALVE (CHECK). Frederick N. Connet and Arthur W. Graham, Providence, R. I. 944,416.

VALVE (STOP). William J. James, Pittsburg, Penn. 944,871.

FEED VALVE FOR STEAM BOILERS. Leo D. Mager, Garrett, Ind. 944,683.

VALVE (STOP). Samuel S. Caskey, Philadelphia, Penn. 944,598.

TIME MECHANISM for Operating Gas and Other Valves. Victor H. Slinack, Philadelphia, Penn. 944,988.

AUTOMATIC VALVE-OPERATING MECHanism. Charles Walker, Charleston, S. C. 944,927.

PUMPS, EXHAUSTERS AND BOILER FEEDERS

INJECTOR. James Metcalfe, James C. Metcalfe, and Richard D. Metcalfe, Fallowfield, Eng. 944,455.

BOILER FEEDER. Vincen P. McVoy, Mobile, Ala. 944,574.

ROTARY PUMP. Carl W. Vollmann, Montreal, Quebec, Canada. 944,708.

CASING FOR CENTRIFUGAL Pumps and Blowers. Heinrich Holzer, Nuremberg, Germany. 944,864.

944,912. ROTARY AIR AND GAS PUMP. Lebbeus H. Rogers, New York, N. Y. 944,912.

ROTARY AIR OR GAS PUMP. Lebbeus H. Rogers, New York, N. Y. 944,913.

STEAM TRAP. Cole Stickle, Indianapolis, Ind. 944,295.

SOCIETY NOTES

The meeting rooms of the Stationary Engineers' Club, of Philadelphia, are located at 1108 Arch street. Meetings are held every Wednesday evening at eight o'clock.

The meeting rooms of Brooklyn Association No. 8, N. A. S. E., were crowded to overflowing on Saturday evening, January 29, at the annual smoker of this popular organization. An entertainment of unusual excellence was given. Refreshments were served at intervals.

The Engineers' Society of Western Pennsylvania held their annual banquet Saturday evening, January 29, in the Fort Pitt hotel. Among the speakers were George H. Neilson, toastmaster; Pres. E. K. Morse; Dr. J. A. Holmes, director technological branch of the United States Geological Survey; Rev. Dr. Maitland Alexander; George C. Johnston and Frederick L. Bishop, the new head of the physics department of the university of Pittsburg.

The National Electric Light Association will hold its next annual convention at St. Louis, Mo., May 23-28, with headquarters at the Coliseum. A formal invitation was received from the League of Electrical Interests and there is every indication that this convention will be most successful, especially as it marks the twenty-fifth anniversary of this body. The Coliseum is a steel and concrete building, somewhat resembling Madison Square Garden, of New York City, and provides excellent facilities for meeting purposes as well as being ideal for exhibition purposes. In view of the extraordinarily large growth in membership since the last convention, it is believed that record numbers will be reached upon this occasion.

The first annual meeting of the Wisconsin Electrical Association was held at Hotel Pfister, Milwaukee, January 19 and 20. This association is devoted to the general betterment of the electrical industry throughout the State of Wisconsin. It is an outgrowth of the old Northwestern Electrical Association and the Wisconsin Street Railway Association, and while this was the first meeting under the new name, both street-railway and electric-lighting interests were represented in the membership.

A pleasing and entertaining social program was arranged for the delegates. Officers selected for the following year were, Clemon C. Smith, president; George B. Wheeler, first vice-president; Urwin P. Ford, second vice-president; W. H. Winslow, third vice-president, and John S. Allen, Lake Geneva, Wis., secretary and treasurer.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City, May 31 to June 6.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association York. Next annual convention, St. Louis, Mo., May 23-28.

ENGINEERS' CLUB OF PHILADELPHIA

Pres., William Easby, Jr.; sec., W. P. Taylor, 1317 Spruce St. Regular meetings 1st and 3d Saturdays.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Dept., Washington, D. C. Pres., Rear Admiral John K. Barton (retired) U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; sec., C. H. Sembower, Reading, Pa.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 525 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

MASTER STEAM BOILER MAKERS' ASSOCIATION

Pres., J. H. Smyth; sec., Geo. M. Clark, 1337 N. Maplewood Ave., Chicago, Ill.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee Peoria, Ill. Next convention, Denver, Colo. September, 1910.

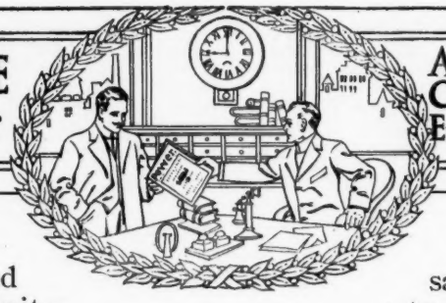
NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O. Next annual meeting at Toledo, O., May, 1910.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, January 16-21, 1911. January 16-21, 1911.

MOMENTS WITH THE Advertising Editor



A Department for Subscribers Conducted by the Business End of Power and the Engineer

Truly, the Business End of most everything is situated well to the rearmost extremity.

Witness the Busy Bee.

And the Business End of POWER AND THE ENGINEER is no exception to the rule.

It's the tender behind—

And carries the fuel!

Because it is the Business End, the advertising department, that makes it possible for you to get the paper at less than four cents a copy when the actual cost of editing and printing a copy is close to one dollar.

A due measure of consideration, then, for the Business End.

Like the stork, it hasn't much to say, but it delivers the goods.

* * * *

Now, be it known that the advertisers do not own the paper; nay, nor any part of it.

Nor do they control any part of it beyond the space they buy and pay for.

Nor can they buy, for love or money or little red wagons, space in any other than the advertising columns.

Nor can they dictate any policy or perpetrate any propagandas, or make any graven images that the publishers feel bound to respect or bow down to.

For POWER AND THE ENGINEER is controlled by and dictated to by its subscribers and none others—

Verily, they are the boss.

And this carries with it certain obligations toward the advertisers on the part of subscribers.

The advertiser looks upon his space as a salesman.

He pays money to have the salesman reach you with his samples and arguments.

And most of this money, minus the publisher's commission, finds its way to your pockets because, as we have said, you get the paper at about a tenth of its actual cost.

So that the advertiser asks for and has a right to a square deal on your part.

Give it to him by the interest you manifest in his proposition.

* * * *

Advertising is a wonderful thing.

Its chief function is to sell things.

In reality, when it is rightly done in the right paper it *creates* a market, upbuilds a business.

Which may sound as if advertising were of benefit only to the advertiser.

Truth is, the buyer is a winner, too.

Because advertising eventually becomes the cheapest method of selling goods, and the selling price can be proportionately reduced.

Because advertising is like a searchlight; it shines so brightly on the advertised goods, they are before the public so constantly, they are subject to such close scrutiny from so many angles that the defects are quickly discovered and remedied.

So you may buy goods that are constantly advertised with a full measure of faith that the price and the goods are *right.*

* * * *

"Substitution" is the evil encountered by many advertisers.

Especially those whose goods have been for years on the market.

The "substitutor" is a mean cuss.

Avoid him.

He is trading on the other fellow's reputation, which has been years in the making.

He's a confidence man of the first water.

And the fellow he fools with his "just-as-good," or his palpable imitation of the real thing—that man is the goat.

Be sure you get what you ask for.

Or walk out.